POWER

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What Are You Doing With Today?

THE Medical Profession has often told us that the normal individual requires at least seven hours of sleep and that the majority would last longer if they "sawed wood" for eight hours. Assuming that for hygienic reasons we spend one-third of our life in bed, how many of us are fully awake the remaining sixteen hours of each twenty-four? It is true one may potter around the plant for eight, ten or twelve hours, as schedule may require, and then are often obliged to spend nights and Sundays there, too.

It is self-evident that the power plant is the heart of the factory or community and that its pulse beat must be uniformly maintained to avoid stopping the wheels of progress. Occasional overtime work for needed repairs or for economy of operation is to be expected and is just as necessary for the engineering profession as for the physician with his night calls or the lawyer with his lawbooks. The important question is not "How much time do we put in," but "How much do we get out of the time we put in?"

There is such a thing as employing our time wisely, usefully and efficiently through the working day in the interest of our employer, as well as during the recreation hours, which belong to us. Time is the one free commodity that is delivered to all in equal quantities without regard to the high cost of living. A fresh supply greets us every morning, and it is ours to dispose of as we see fit or as our circumstances dictate. We can use the fleeting moments as they pass, but we cannot squander the future or recover the past.

How often we think of the things we plan to do some day when we have time, little realizing that we already have had all the time there was and are still receiving our daily quota! How are we going to fulfill those ambitions to rise higher in our profession or occupation, to increase our fund of knowledge, to enlarge our earning value or sphere of influence, to be of greater service to others when we have so little spare time?

Success cannot be obtained without consistent effort and personal inconvenience. It requires a more systematic use of the twenty-four hours we are privileged to enjoy each day. It may necessitate rising half an hour earlier or staying up half an hour later, or of skimming through newspapers instead of perusing in detail the daily scandals and unique advertisements. Or it may mean useful reading on trains or trolleys instead of sky-gazing; of improving idle moments by controlling our thoughts and directing them into useful channels.

Cannot certain nights in each week or some of the week-end hours be regularly reserved for useful pursuits, for educational reading or recreational hobbies? Then one will have the satisfaction that at least a portion of his surplus time is productively applied, and in later years he will be spared the remorseful query, "What have I done with my Opportunities?"

Contributed by H. T. MOORE

THE SYNCHRONOUS MOTOR IN OPERATION

By

*Will Brown**

Horseshoe magnet illustrations make it easy to understand the operation of the synchronous motor under load, the difference between it and the induction motor, the starting operations, the importance of pull-in torque and its relation to starting torque. Increasing use of the motor for driving machines of constant speed.

IN FIGS. 1 to 4, are illustrated the actions of a synchronous motor when running under load. Two horseshoe magnets represent the stator field and rotor field. Line current is represented by the upper hand grasping the stator magnet. Mechanical load on the motor is represented by the lower hand grasping the rotor magnet. The arrow indicates the direction in which the stator magnet is moving. The rotor magnet being locked with it, is moving at the same speed. Fig. 1 indicates the position of the stator and rotor poles (magnets) when the motor is in step with the line and running with no load. Notice that the south pole of the rotor is exactly opposite the north pole of the stator, and vice-versa. The center points of the stator poles, *A* and *B*, coincide with *A'* and *B'*, the center points of the rotor poles. When the motor is carrying load the relative position of the stator and the rotor poles is shown in Fig. 2. Notice that points *A'* and *B'* of the rotor have slipped back from *A* and *B*. Remember that the stator magnet automatically increases in power as the rotor magnet slips until a point is reached where the pull of the line balances the pull of the load. Fig. 3 shows the position of the stator and rotor poles when the load on the motor has pulled the rotor back half the distance of a pole face. Notice that the north pole of the rotor is only half covered by the south pole of the stator, and that the north pole of the stator now repels the north pole of the rotor. The line current is very heavy and the motor is unstable as it approaches this point.

In Fig. 4 the load has literally pulled the rotor poles away from the stator poles. As soon as the point is reached where the north pole of the stator opposes the north pole of the rotor the pull of the line snaps like a rubber band and the rotor is brought to a dead stop by the heavy pull of the load.

If one keeps this picture in mind of the magnets of the stator constantly dragging the magnets of the rotor it will be easy to point out the difference between the induction and synchronous motor. An induction motor can develop no torque unless the rotor bars are cutting lines of force from the stator. As soon as the line current is thrown on the stator these lines of force start revolving at synchronous speed just as in the case of a synchronous motor. These lines are cut by the rotor bars and induce a current in them. This current causes a magnetic field to surround the motor bars. This magnetic field forces the rotor forward in an attempt to catch up with the stator field. It is evident, however, if the rotor and the stator are revolving at the same speed, that the rotor bars cannot be cutting any lines of force, consequently there will be no current in the bars and no torque in the motor. For this reason if there is any load on the motor, the rotor must slip back a certain percentage from synchronous speed. This slip speed at full load is known as the motor's rated speed and any addition to the load reduces the speed to some extent. The squirrel cage bars on synchronous-motor pole faces produce the exact duplicate of an induction motor rotor. The starting torque (in proportion to kv.a. input) will be higher gen-

VERTICAL SYNCHRONOUS MOTOR WITH DIRECT-CONNECTED EXCITER

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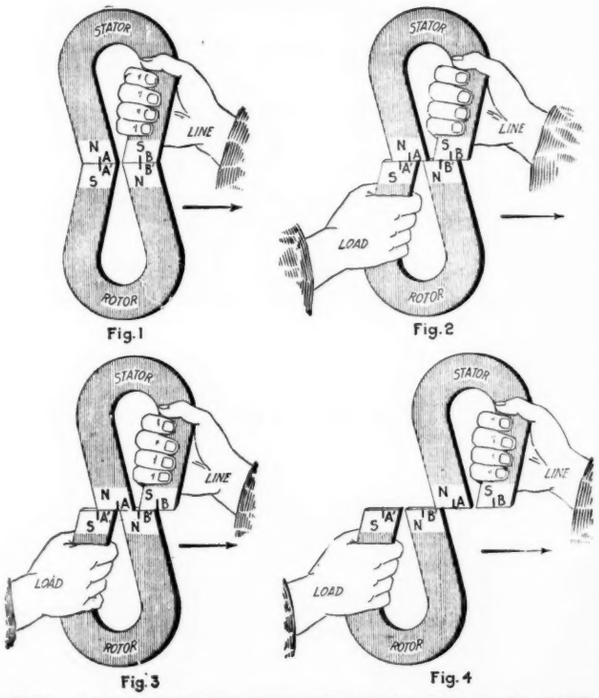
erally in the case of a synchronous motor than in a squirrel-cage motor. The reason for this will be explained later.

A synchronous motor is started at part voltage as an induction motor and quickly comes up to a certain slip speed. At this point the synchronizing power of the line begins to make itself felt. Definite magnetic poles have been built up in the rotor by induction in the field windings, since no direct current is supplied to the field until later. Every time a north pole of the stator passes a south pole of the rotor or vice versa, the poles attempt to lock together. But as yet the magnetic pull is not strong enough to get the rotor up to speed. Then the operator throws full voltage onto the motor and this immediately strengthens the stator fields so that its poles can pull the rotor poles along at synchronous speed.

When the load increases on a synchronous motor, the exciting current remaining fixed, the rotor poles drag back a small distance in relation to the stator poles and this automatically causes an increased current to flow



FIGS. 1 TO 4. SHOWS THE RELATION BETWEEN THE ROTOR AND STATOR POLES OF A SYNCHRONOUS MOTOR

from the line into the stator winding. Since there is no corresponding increase of exciting current the power factor tends to become lagging. Conversely when the load is removed and the excitation remains constant the power factor tends to become leading.

Now if the reader has carefully followed the description up to this point he can form a mental picture of the starting operation. He can also understand the importance of the synchronozing power or pull-in torque of a synchronous motor. It is this feature of pull-in that limits the starting torque as well.

To explain this point by a mechanical means consider the illustration in Fig. 5. Two concentric disks *S* and *R* are revolving at different speeds on the same shaft; *S* represents the stator field, *R* the rotor field, *A* is a slot on disk *R* and *P* is a plunger on disk *S* which will automatically plunge downward at the instant slot *A* is passing under it. The two disks will then be locked together. Assume that *S* is revolving at a fixed speed of 200 r.p.m. and that *R* starts at zero and increases in speed. In the figure *R* has arrived at a speed of 100 r.p.m., that is 50 per cent. slip speed. For every one revolution of *R* two revolutions are made by *S*.

Now when the plunger *P* is forced into slot *A* one of two things will happen: Either disk *R* must immediately

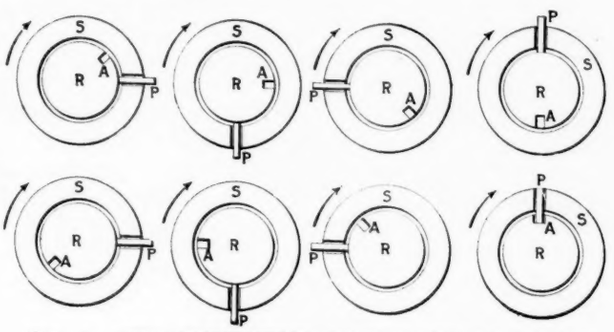


FIG. 5. TWO CONCENTRIC DISKS SHOWING HOW A SYNCHRONOUS MOTOR PULLS INTO STEP

revolve at the same speed as disk *S* (it is assumed that the speed of *S* is fixed) or plunger *P* must break. In either case disk *R* will receive a jerk. The plunger represents the magnetic pull of the stator. If the plunger breaks, assume a fresh plunger of the same strength automatically takes position ready to lock the disks together when *P* passes *A*. But these plungers will all break if the speed of *R* is not increased. As the speed of *R* is further increased the jerking strain on each plunger will grow less at each time until there comes a point where the plunger is strong enough to lock the two disks together without breaking. Disk *R* has been pulled into step with *S* and now revolves at synchronous speed.

In this operation there are three factors that must be taken into account: The load on *R*, the slip speed of *R* and the strength of *P*. The strength of *P* is limited by the current which can safely be drawn from the line.

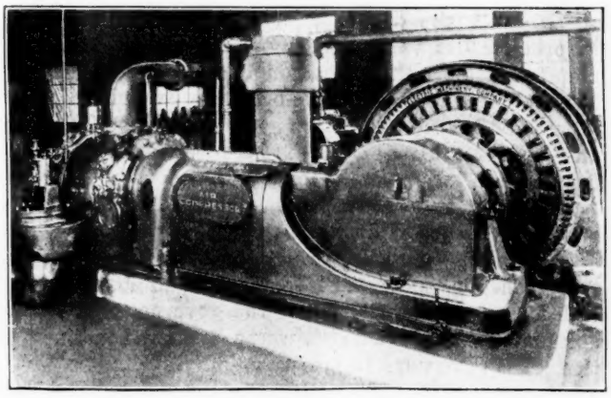


FIG. 6. SYNCHRONOUS MOTOR DRIVING AIR COMPRESSOR

The load on *R* is determined by the characteristics of the machine which the motor must start; as for example, a compressor or a pump. The speed of *R* must be brought close enough to the synchronous speed that the magnetic pull of the stator can accelerate it to full speed. If a synchronous motor was designed for the highest starting torque possible under induction-motor construction it would have a maximum slip speed so

low that it would never be pulled into step. That is why it is necessary to limit the starting torque of a synchronous motor in order to develop sufficient pull-in torque and carry the load under the critical pull-in period.

There are always three important points in the starting of a synchronous motor:

First: It must be able to start up the load from rest.

Second: It must accelerate its load quickly to maximum slip speed.

Third: It must have synchronizing power sufficient to pull the load into step.

As a matter of fact a synchronous motor can be designed for higher starting torque (generally speaking) than a squirrel-cage motor. If the squirrel-cage motor is designed for very high starting torque it means a comparatively poor efficiency at full speed. The synchronous motor can neglect this matter of efficiency at full speed entirely, because once pulled into synchronism its induction-motor characteristics no longer affect it.

Today the synchronous motor is being used for driving machines of constant speed where the starting load can be kept within reasonable limits. They will be found in the shipyards, mines and factories driving air compressors, driving ammonia compressors in ice plants and packing plants, driving the Jordans, grinders and beaters in paper mills, the heavy rolls in rubber mills, centrifugal pumps, some types of reciprocating pumps, fans and blowers and crushing and grinding machines of various types. They are well adapted for heavy line-shaft duty where the fluctuations of load would ordinarily produce low power factor on an induction motor. Many plants are replacing a number of small individual drive machines with group drive in which a fair-sized synchronous motor operates at high efficiency and high power factor.

The practical performance of a synchronous motor can be explained easily to anyone who possesses the mental picture that this article has tried to convey. For instance, it can be seen that the question of flywheel is an entirely different matter with an induction motor which has a slip with every variation of load,

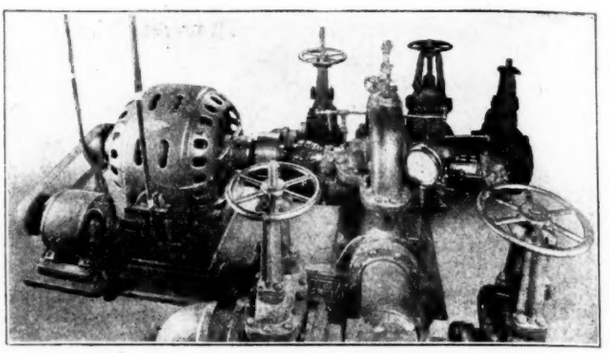


FIG. 7. SYNCHRONOUS MOTOR DRIVING CENTRIFUGAL PUMP

to that of a synchronous motor which permits no slip whatever, but does allow a certain angular displacement limited to a brief fraction of a second.

This rugged high efficiency motor is rapidly forcing a place for itself in all kinds of industry. The later designs are superior to older types both in starting torque and pull-in torque, and further improvement can be looked for. No one can say just what the limit will be in this respect.

Methods of Obtaining Close Speed Regulation

By W. TRINKS*

ALTHOUGH close speed regulation has been sought by engineers ever since prime movers were first built, the degree of closeness actually attained in practice has varied greatly with the increasing demands made by the operation of spinning machinery, electric generators and coke-oven gas exhausters. The process of striving for close speed regulation led many an engineer into wrong paths because conclusions were drawn from incomplete theories.

It is well known that one governor designer after another tried to build a successful isochronous governor —that is to say, a governor that would maintain a truly constant speed—and that one after another they failed. As a rule, the better the governor was in the opinion of the designer, the worse it showed up in practice. The governors designed from 1850 to 1890 all had too much mass and too much friction to be successful. Toward the end of the nineteenth century, high-speed, spring-loaded spindle governors and inertia shaft governors were introduced. The latter type solves the problem of close governing, but attempts made to apply the inertia principle to spindle governors were in the main unsuccessful for this reason. While the inertia shaft governors were used on small engines driving direct-current generators, the spindle governors built on the inertia principle were applied to engines driving alternating-current generators, and the parallel operation of alternators requires that the governor be designed with a steady speed rise between full load and no load. Alternating-current work required perfect speed characteristics, and as soon as spring-loaded, high-speed governors with such characteristics were introduced, the inertia principle offered no advantages, but decided disadvantages, because inertia mass increases the total moving mass of the governor.

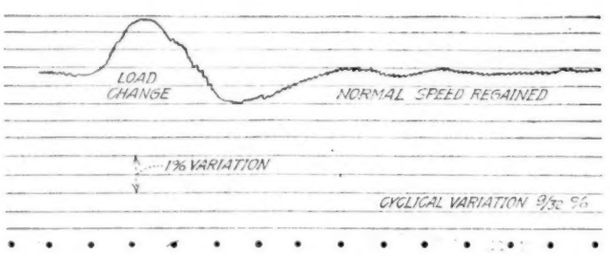


FIG. 1. WAVES SHOWING CHANGE OF SPEED WITH CHANGE OF LOAD

Slowly, step by step, governor designers recognized the necessity of building high-speed governors exerting great force with small mass. Likewise, it took time to recognize the harmfulness of solid friction and the elimination of such harmfulness by vibration. Parsons was the first engineer to intentionally intro-

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duce governor vibration in connection with his steam turbine (puff governing). The improvements in governor design allowed gradual approach to isochronism without making it possible to reach it. In a way it will never be reached; sudden changes of load will always produce a change in speed, because it is evidently impossible to produce a centrifugal force without mass. After a few seconds the engine or turbine may regain its original speed, but not until several speed waves have been completed, as shown in Fig. 1. In order to accomplish the return of the speed to the orginal value or very close to the original value, the governor must be equipped with temporary stability, which means it must be so designed that quite a speed change is required to make it move away from its instantaneous position of equilibrium, and that the force compelling the speed change gradually disappears after the disturbance of equilibrium (load change). The first American record of such an arrangement appears to be the description by Mr. Armstrong, of Erie, Penn., of a shaft governor in which a moving piston fits snugly in an oil-filled, elongated cavity of the main centrifugal weight (see Fig. 2). Whenever the governor parts change their configuration—that is to say, when the engine regulates—the main centrifugal weight and the auxiliary weight move as one solid entity, but for every different position of the main weight the auxiliary weight will arrange itself differently relative to the main weight because of the form of the cavity. The arrangement just described has been forgotten because it cannot be applied to spindle governors. On the other hand, the principle in question can easily be applied to spindle governors, as will be seen from Fig. 3, which diagrammatically represents a spring-loaded gagpot. It will be noticed that the main piston of the gagpot floats between springs which abut against the two ends of a hollow box piston. The main piston has a comparatively large hole, while the box piston has a very small hole at each end for the passage of oil. The springs exert a force on the main piston in proportion to its displacement relatively to the box piston and give the governor the required stability, but the box piston gradually yields, the springs lose their tension, and the stability is removed.

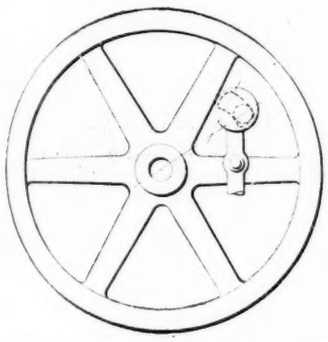

FIG. 2. OIL-FILLED CAVITY IN CENTRIFUGAL WEIGHT

In the United States this principle has been extensively used in relay governors for hydraulic turbines, but there appears to be no application of it in direct control governors. In England, on the contrary, the principle of temporary stability has been extensively used in direct-control governors, of which the "Bee" governor (Eastman's patent) and the Chorlton-Whitehead governor are good examples. The latter is illustrated in Fig. 4. In the language of the builder of the governor, its action is described in the following paragraph:

"The spring on one side is divided into two unequal portions, *A* and *B*, a plate *C* forming the piston of an oil gag being interposed between the two portions. The oil gagpot itself is formed in the weight and is provided with a small adjustable valve *D* by means of which free communication can be made from the gagpot to the body of the governor. The bottom case being entirely filled and the top portion about four-fifths full of oil, the governor is ready for work and the action will be as follows: If the gagpot valve is wide open so that oil has a free passage to and from the interior, the gagpot piston will be quite free to move, and the divided spring will behave as one complete spring, the piston merely acting as a washer. The compound spring in this condition is exactly equivalent to the single spring in the other weight, and both are designed to exactly counteract the centrifugal force of the weights in all positions when running at constant speed; in other words, the governing is isochronous, and to run in this condition would cause it and the engine to hunt violently, as the governor would have no stability. If, on the other hand, the valve is closed, the gagpot becomes immovable and puts the shorter spring out of action. We have thus decreased the effectual length of the spring, and the governor will run with a certain amount, say 8 per cent., of the variation between the inner and outer positions, making the governor very stable—too much so, in fact, for close governing. If now the gagpot valve be partly opened, a point can be found where hunting does not take place, and still the governor will be in equilibrium after a certain time has elapsed, allowing the gagpot piston to move to its new place; in other words, the governor will be isochronous subject to a certain time lag, amounting to two or three seconds.

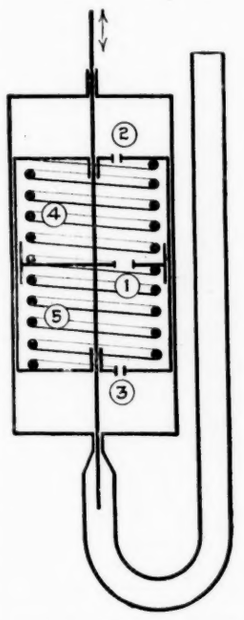

FIG. 3. DIAGRAM OF SPRING-LOADED GAGPOT

Full explanations of the underlying theories and of the applications will be found in the book, "Governors and the Governing of Prime Movers," by the author.

It is necessary to properly pitch and drain pressure pipe lines with pipes of ample size to take care of the rapid condensation of the steam when first turned into the line. If traps are used, they should be located below the line to drain it dry when steam is shut off. It is good practice to put a bleeder on the end of the line farthest from the steam inlet to help remove the rapid condensation which is bound to take place when the steam is first turned on.

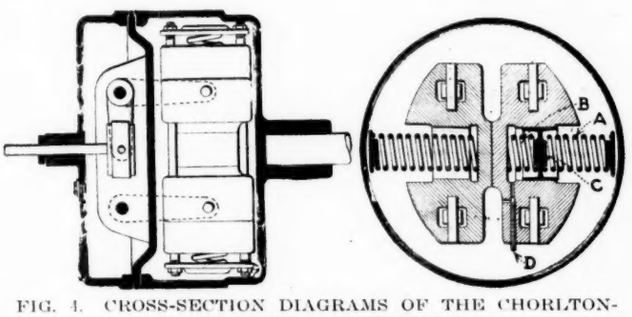

FIG. 4. CROSS-SECTION DIAGRAMS OF THE CHORLTON-WHITEHEAD GOVERNOR

Automatic Pump Control

By B. N. EVERETT

A number of arrangements of automatic pump-control apparatus that have been satisfactorily employed are illustrated diagrammatically, and their methods of operation are explained. These controls are for motor and belt-driven power pumps of both plunger and centrifugal types.

IT IS better economy in some cases to use power-driven pumps rather than direct-acting steam pumps. In plants that can make use of all the exhaust steam from direct-acting pumps and in plants where the load factor is so low that the matter of initial cost controls the selection, steam pumps show better over-all economy, and it is a simple matter to apply automatic control to direct-acting steam pumps. In every power-pump installation the matter of control should be given consideration as it often means the difference between efficient and inefficient operation.

The accompanying sketches show diagrammatically a number of arrangements of automatic control apparatus which have been satisfactorily employed.

Fig. 1 represents an application to a motor-driven triplex pump to feeding one boiler. When the water level reaches the low point, the float-operated pilot valve of the feed-water regulator *A* opens so as to admit pressure from the boiler into the diaphragm chamber of the diaphragm-operated switch *B*. The closing of this switch supplies the current for operating the starting rheostat *C* which controls the pump motor *D*. At high-water level the regulator *A* exhausts the control pressure to the atmosphere and the pump motor is stopped. A small air chamber *E* on the control pipe acts as a dashpot, retarding the operating control in such a manner that it will not be affected by a surging water level. With this control the power consumed is proportional to the quantity pumped.

Fig. 2 control uses a similar feed-water regulator *F* for one boiler, but in this case the pump runs continuously and the control is through the medium of a diaphragm-operated bypass valve *G*. At high water the bypass is open and the pump runs idle. The power consumption in this case is that required to pump the water plus that required to run the pump idly during the periods that the bypass is open.

If more than one boiler is to be fed by a power pump belted to a lineshaft or engine, the arrangement shown in Fig. 3 may be used. This consists of an excess-pressure control valve *H* placed on the bypass of the pump. This valve is adjusted so as to remain open only enough to maintain any desired excess pressure in the feed line above boiler pressure. The feed to each individual boiler is then controlled either by the hand valve *I*, or by the feed-regulator *J*. The power consumed with this arrangement of control equals the maximum capacity of the pump at the operating pressure.

Less power will be consumed when it is possible to change the speed of the pump. An engine-driven pump may be varied in speed by placing a pressure-control valve in the steam line to the engine, as in the case of direct-acting pumps. Figs. 4 and 5 indicate variable-speed arrangements for electrically driven pumps. Variable-speed motors are used, and the regulation is accomplished by means of a pressure-controlled, hydraulically operated rheostat. The hydraulic device is

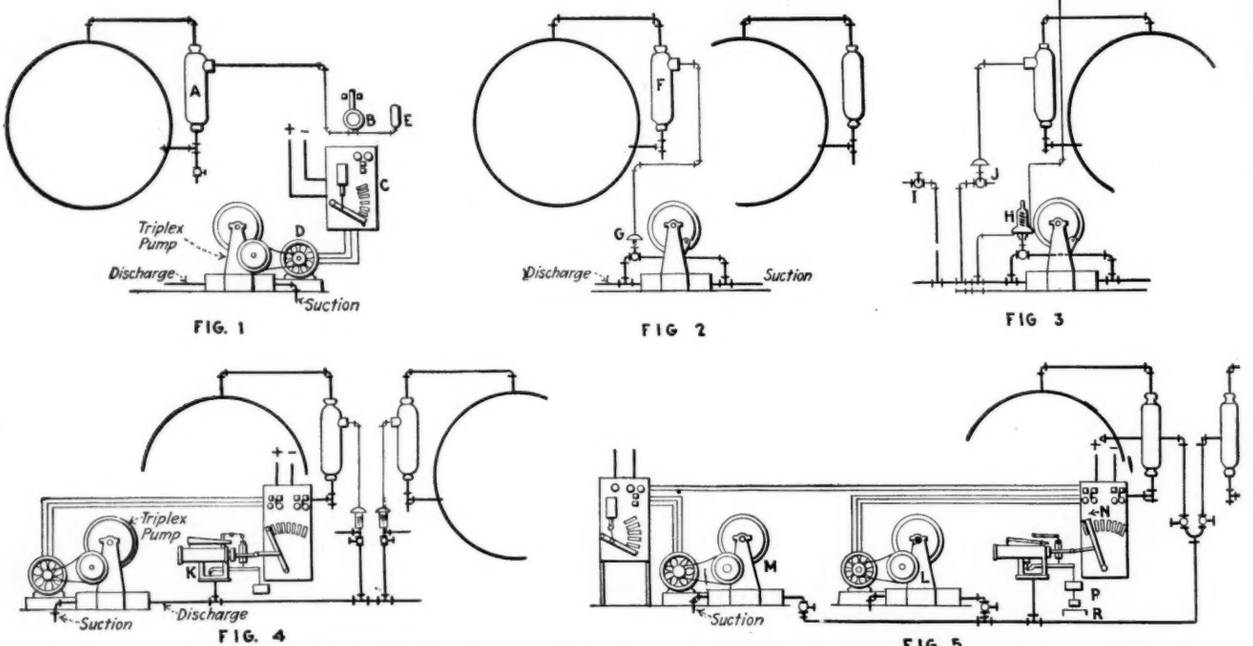

FIG. 1 FIG 2 FIG 3

FIG. 4 FIG. 5

FIGS. 1 TO 5. SEVERAL TYPES OF POWER PUMP CONTROL

Fig. 1—Motor-driven triplex pump control. Fig. 2—Pump bypass controlled by diaphragm-operated valve. Fig. 3—Bypass controlled by an excess-pressure valve. Figs. 4 and 5—Pump speed controlled by variable-speed motors that are controlled by a pressure-controlled hydraulically operated rheostat.

similar to a hydraulic damper regulator, but the cylinder is horizontal. The power consumption with control, Fig. 4, will vary with the amount of water delivered, but will not be exactly proportional, as the efficiency is less at slow speeds.

In Fig. 5 two pumps are used, one of which, *L*, is equipped with a variable-speed motor, and the control is the same as shown in Fig. 4. The other pump *M* is run by a constant-speed motor and is under the control of the self-starter *N*. At ordinary loads, up to the capacity of the pump *L*, the control is the same as in Fig. 4. At heavier loads the control is as follows: When the rheostat arm has reached its extreme travel to the left, it makes a contact at *N* which closes the control circuit of the self-starter. As soon as the pump *M* starts, however, the pressure will rise, causing the pump *L* to slow down to a speed only sufficient to maintain the pressure. Pump *M* then keeps running until the pressure is such as to cause the rheostat arm of pump *L* to reach its extreme right travel. At the maximum speed of the pump *L* the weight *P* comes to rest upon its support *R*, thereby relieving the diaphragm of so much weight. This action takes place just before the rheostat arm makes the contact at *N* which starts the other pump. It will be seen, therefore, that even after the pump *L* has attained its maximum speed, the pump *M* will not start until there has been a further drop in pressure. The power consumption with this arrangement of control is less than that shown in Fig. 4, as the pumps operate with a better load factor. It is adaptable to classes of pumping requiring varying quantity at uniform pressure.

Pumps in pressure service driven by gas engines or from lineshafts are often automatically controlled by means of a hydraulic belt shifter, Fig. 6. It is similar to the hydraulic mechanism which operates the rheostat in Fig. 4, but it is provided with an auxiliary weight which is lifted from the diaphragm at the idle position of the shifter. It provides that a drop in pressure of a predetermined amount takes place after the pump has been stopped, before it will start again. The same device may also be used to operate a friction clutch. The control is preferable for service where the pump is idle much of the time, as there is a saving of power over that shown in Fig. 7; but when the control is very intermittent, as in hydraulic-elevator service, most engineers prefer the hydraulically operated bypass valve arranged similar to that which is shown in Fig. 7.

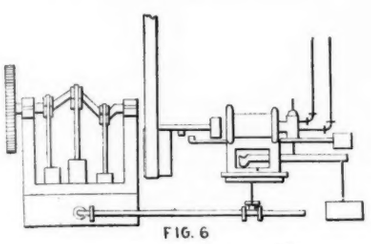
FIG. 6

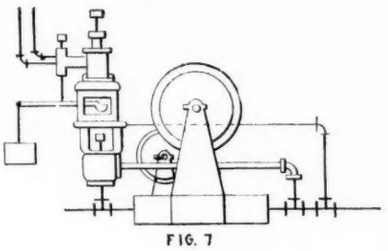
FIG. 7

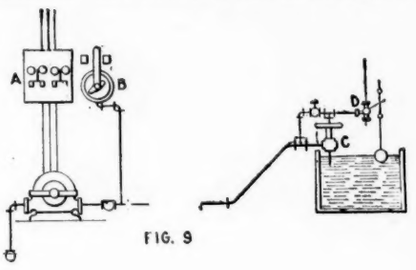

FIG. 9

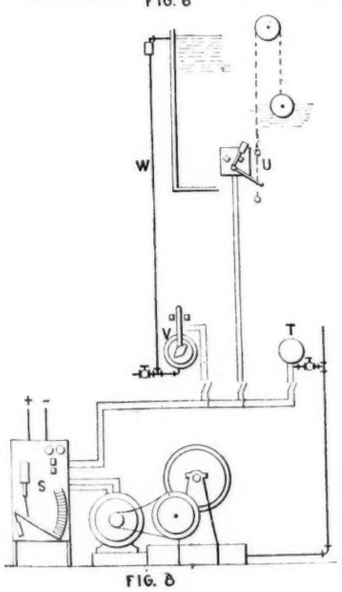

FIG. 8

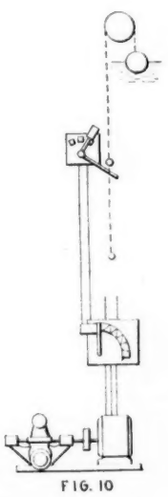
FIG. 10

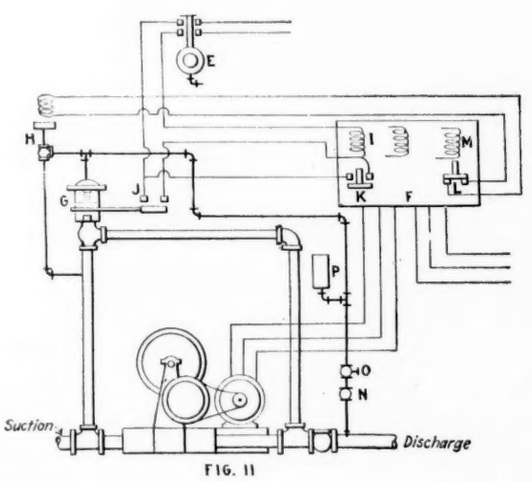

FIG. 11

FIGS. 6 TO 11. MORE TYPES OF CONTROL FOR POWER PUMPS

Fig. 6—Control for pumps used intermittently. Fig. 7—Hydraulically operated bypass control. Fig. 8—Control for overhead tank pump. Fig. 9—Control for motor-driven pump at a distance. Fig. 10—Motor-driven tank-pump control. Fig. 11—Control for relieving the load at starting.

Fig. 8 indicates different methods of controlling pumps supplying overhead tanks. As shown, *S* is an automatic motor starter which may be controlled by the different pilot switches shown; *T* indicates a pressure-gage type of pilot switch (if the friction head is considerable, or if there are service connections between the pump and tank which might reduce the pressure, this control is not practical); *U* represents a pilot switch closed and opened by a float; *V* represents a diagram type of pilot switch connected in such manner that when the tank is full the pressure pipe fills with water. When the water falls below the pressure-pipe connection, the pressure is relieved through the drip valve at the bottom and the pilot switch closes.

Controls *T* and *U* are adjustable both as to starting and stopping levels, but the control *V* is not adjustable.

The small reservoir at the top of the control pipe is uncovered.

Fig. 9 represents an arrangement of control of a motor-driven pump, located at a distance, through the medium of its discharge pipe. The control apparatus consists of a self-starter *A* and a diaphragm switch *B*, similar to that used in Fig. 1; a diaphragm-operated balanced valve *C* and a float-operated three-way pilot valve *D*. The pilot valve is connected to a source of water under pressure. When the reservoir is full, the float-operated pilot valve admits pressure to the diaphragm chamber of the valve *C*, shutting off the pump discharge. There is a small connection which admits water into the discharge pipe, causing the pressure to rise enough to operate the switch *B* at the pump end of the line. At low water level the float trips the weighted lever of the pilot valve and the pressure is exhausted from the diaphragm valve, which opens and the pump starts.

Figure 10 shows a simple idea for stopping a tank-pump motor. It consists of a float switch in series with the magnet of a starting rheostat. The switch opens when the tank is full and the rheostat arm flies back, stopping the motor. It must be started by an attendant.

When squirrel-cage motors are used to drive reciprocating power pumps, means must be provided for relieving the load at starting. This may be done by opening a bypass valve and closing it after the motor has come up to speed. It is, however, desirable to keep the bypass closed while the pump is idle, because then if the discharge check-valve leaks, both the discharge and suction valves must also leak before water will slip back.

Fig. 11 shows the control diagram for the conditions just described. It consists of a pilot switch *E* which may be of the diaphragm-operated type or float-operated; a magnetic self-starter *F*, a diaphragm-operated bypass valve *G* and a magnetic pilot valve *H*, together with two spring control switches *J* and *K* and another one *L* which is normally closed. When the pressure of water level falls to the point for which the switch *E* is set, the switch closes, thus energizing the solenoid that opens the pilot valve *H*. This relieves the pressure in the diaphragm chamber of the bypass valve *G*, permitting it to open and, through the medium of a small lever connected to the valve stem of the bypass valve when in its wide-open position, closes the control switch *J*, which furnishes the control circuit to the

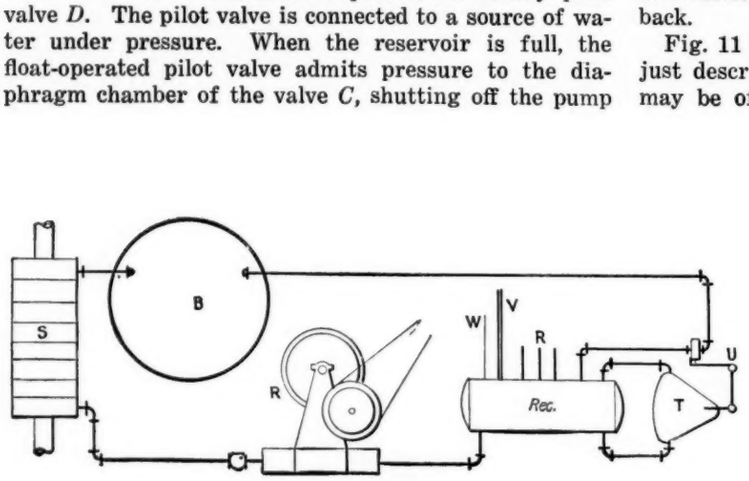

FIG. 12

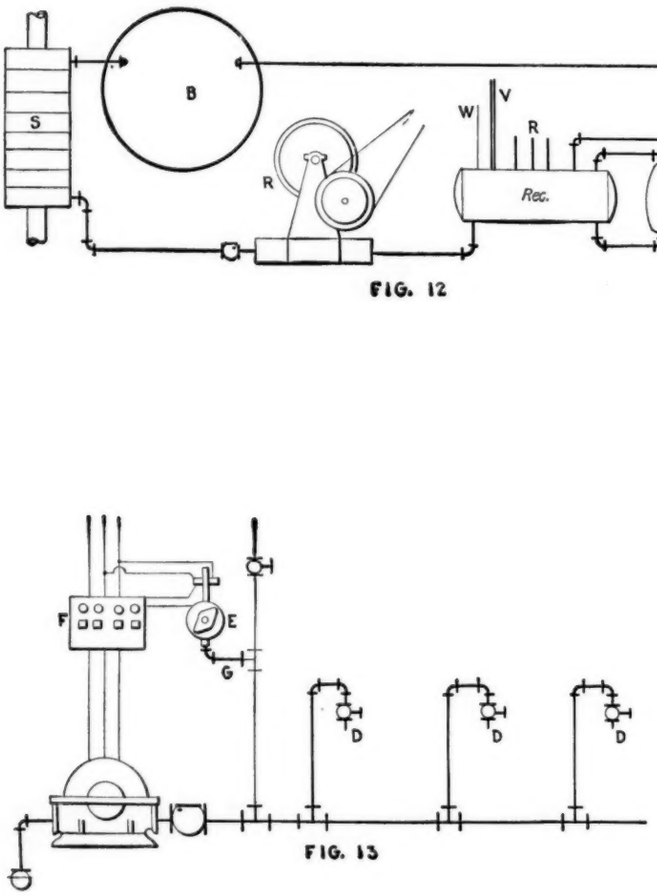

FIG. 13

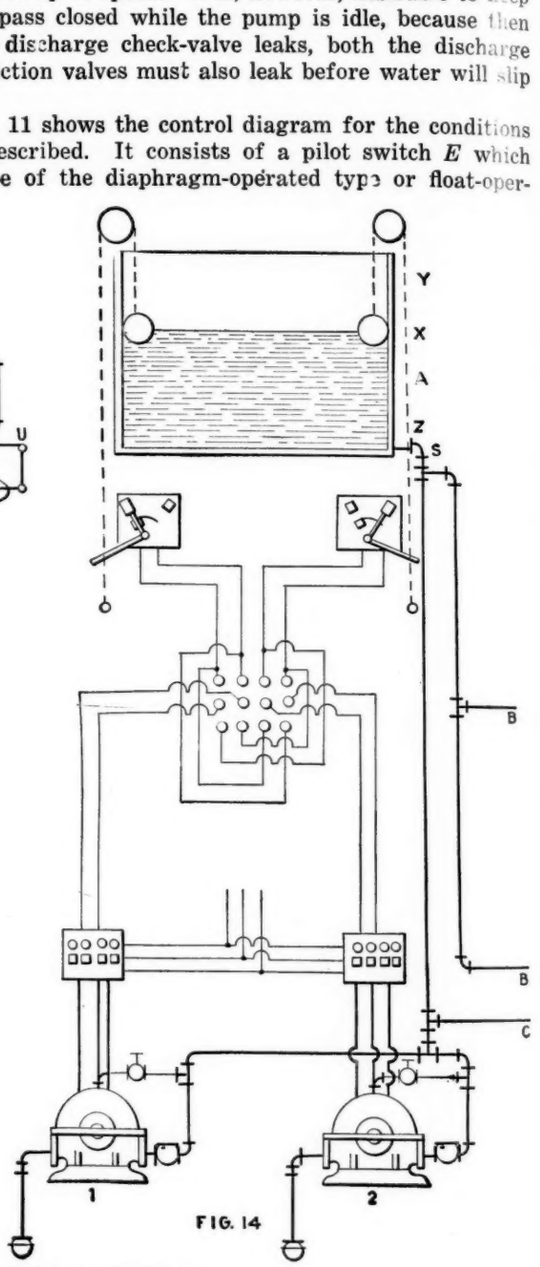

FIG. 14

FIGS. 12 TO 14. SOME SPECIAL CONTROL SYSTEMS

Fig. 12—Control for a return power pump. Fig. 13—Control for motor-driven pump handling warm water. Fig. 14—Control for two centrifugal motor-driven pumps

self-starter solenoid *I*. The control switch *K* is closed by the action of the solenoid *I*, which also closes the first switch of the starter *F*. This switch, not being part of the special control, is not shown. The control switch *K* is in parallel with the control switch *J* and supplies current to the solenoid *I* after the bypass has closed again and the control switch *J* is opened.

A solenoid *M* represents the final switch magnet which throws the motor directly across the line, after it has properly accelerated. Besides closing the motor switch (not shown), it opens the control switch *L*, which causes the pilot valve *H* to close when the pressure from the discharge side of the discharge check-valve closes the bypass. At the required pressure or water level the control current is cut off and the motor switches open. A strainer *N* is connected in on the control pipe; *O* indicates a small valve for throttling the control pressure and *P* is a small air chamber. The function of *O* and *P* is to cause a small interval of time after the main switch closes before the by-pass valve closes.

A special pump application and method of control is shown in Fig. 12. In this case the pump *R* handles the return from the heating system receiver and discharges it to the low-pressure heating boiler after passing through a heater *S* using exhaust from the gas engines which run the plant. The pump is run continuously to insure the heater from burning and to accomplish as great a heat transfer as possible. As the pump has a greater capacity than the returns alone will supply, a makeup connection is taken from the boiler and it is controlled by a float *T* and a balanced valve *U* so as to maintain a constant water level in the return receiver. When the heating load is not heavy, the heat from the gas-engine exhaust is enough, so no fire is required under the boiler *B*. The cold makeup-water connection is balanced at *W*, and *V* indicates an atmospheric vent pipe.

Control for Two Centrifugal Motor-Driven Pumps

In Fig. 14 is shown an arrangement of the control for two centrifugal motor-driven pumps, pumping water for cooling gas engines and for general service. The tank is for control purposes only and is not intended to furnish water except for a very few minutes. The control is similar to that shown at *U*, Fig. 8. Pump No. 1 starts when the water has reached the level indicated by *X* and stops at *Y*. Pump No. 2 starts only when the water level in the control tank has fallen nearly to the bottom of the tank, or point *Z*, and stops when about at *A*. The service connection *B* being just under the tank and the connection to the gas engines *C* being near the pumps, insures that if the water being pumped is less than what is required, the available supply will go to the gas engines first. Each pump has a capacity that exceeds somewhat the maximum demand for cooling water.

With this arrangement if one pump goes out of commission the other takes on automatically as much of the work as it can do and the gas engines are served first. Each pump is fitted with a foot valve and a small bypass to the top of the casing. This bypass keeps the pump from becoming airbound and is properly a part of the control system. The pilot-switch control circuits pass through a four-pole double-throw switch, as shown, which permits an equalization of the work from day to day.

The characteristics of centrifugal pumps are such that automatic control may be applied by simply throttling the discharge. The efficiency at reduced capacity is poor, and considerable power is consumed when running idle. It is best when conditions permit to use a system of control which starts and stops the motor.

Fig. 13 illustrates a motor-driven pump handling warm water, discharging it to finishing machines in a woolen mill. An operator desiring to fill one of the machines simply opens the valve at his machine *D*, and the pump starts. When he shuts the valve, the pump stops. The motor is controlled by a pressure-operated switch *E* and an automatic switch *F*. A small connection *G* from an overhead tank is used to maintain the pressure, which holds the valve *E* open as long as the valves *D* are all closed. When the pump is running, a small amount of cold water is added through the connection *G*, but the amount is negligible.

Pilot Lights, Electric Meters, Etc.

The operation of automatic apparatus may be checked and observed at a distance by means of telltale pilot lights, electric meters, etc. For example, an engineer has on his gageboard an ammeter indicating the current consumption of an electrically driven pump a mile away, also a long-distance level indicator which shows the level in the reservoir served by the pump. On the level indicator he has marked the point at which the pump stops and starts, and the ammeter not only tells him when the pump is running, but gives an indication of abnormal conditions. If an oiler has tightened the glands so as to cause excessive friction, the current consumption will be greater than normally. If a pump valve is broken, the current will fluctuate with each revolution of the pump, or if the pump becomes badly airbound or loses its suction, the current consumption will be abnormally low, and as the control circuit passes through his engine room, he may stop the pump and send an attendant to correct the trouble. Automatic control not only frequently means a saving in the wages of a pumpman, but the pumps actually get better attention under the occasional examination of an expert than they would with a poorly paid pumpman.

The results of an investigation into the speed of rusting of steel containing small proportions of copper are given by Mr. D. M. Buck in a paper read before the American Society for Testing Materials. This research has determined that the principal protective effect is exerted by proportions of copper so small that most analysts would report them only as traces. Increasing the copper content from 0.01 per cent. to 0.03 per cent. decreases the corrosion by 30 to 40 per cent. With a normal sulphur content of about 0.05 per cent., a copper content of 0.12 per cent. gave virtually as complete protection as larger amounts. A copper percentage of 0.15 per cent. is considered sufficient to protect steel even with considerable excess of sulphur.

In any work of babbitting all preparations should be made in advance of the heating of the metal such as cleaning and heating the bearing shells and making the molds or dams for pouring. Never pour babbitt into wet or damp castings. After a bearing is cast do not forget to drill the oil holes and cut the oil grooves before scraping and do not cut the grooves too deep or too near the ends of the bearing.

Loss Due to Carbon in Furnace Refuse

By C. H. BERRY*

IT is common to treat as pure carbon the combustible which passes through the grates or over the dump plates together with the ash. The causes of this loss are worthy of detailed study. In hand-fired furnaces some fine coal may fall in a hole in the fire, where the grate is bare or nearly so, except for a layer of ash. The green coal lying where the hole formerly was, will impose increased resistance to the flow of air and will for a time be at relatively low temperature. The fine coal at the bottom will be the last to reach the temperature of the fuel bed and may easily drop through the grate before it has an opportunity to burn, especially if the coal lying above it forms clinkers which further interfere with the air supply.

Another cause of this loss is the use of the hook or slice-bar on the fire. This operation will rake a certain amount of coke through the grates and will mix ash and coke together above the grates, making the combustion of such coke less likely, with an increased probability of losses.

In stoker-fired furnaces there is not the same likelihood of loss through holes in the fire, but under certain conditions unburned coke will reach the tail end of a chain grate or the dump plates of an underfeed or overfeed stoker and will there mingle with the ash and pass into the ashpit. The increase of this loss due to the use of the hook or slice-bar holds in the case of stoker firing as for hand-firing.

The losses resulting from the failure to burn this lost coke depend upon two factors—the percentage of ash in the original coal and the percentage of carbon in the furnace refuse. Both of these quantities are determined by laboratory analysis of samples of the coal and refuse respectively. That we may reach a correct method of computing the heat loss, let us examine the problem in detail.

The ash in the coal fired either passes up from the fire as dust or drops of molten slag, or else passes down into the ashpit. Since the proportion of the total ash that passes up from the fire is small, it can safely be neglected for the present purpose. Assume, therefore, that all the ash in the coal passes down to the ashpit. Along with it there also passes down a quantity of coke. The diagram, Fig. 1, will help to make clear the relations involved. The coal fired is assumed to have the composition: Moisture, 5 per cent.; volatile matter, 34 per cent.; fixed carbon, 51 per cent.; ash, 10 per cent. If one pound of this coal be considered, it will contain 0.05 lb. of moisture, 0.34 lb. of volatile matter, 0.51 lb. of fixed carbon and 0.10 lb. of ash, as indicated graphically at the left of Fig. 1. All the ash and some of the fixed carbon contained in the coal pass into the ashpit, and together they make up the furnace refuse.

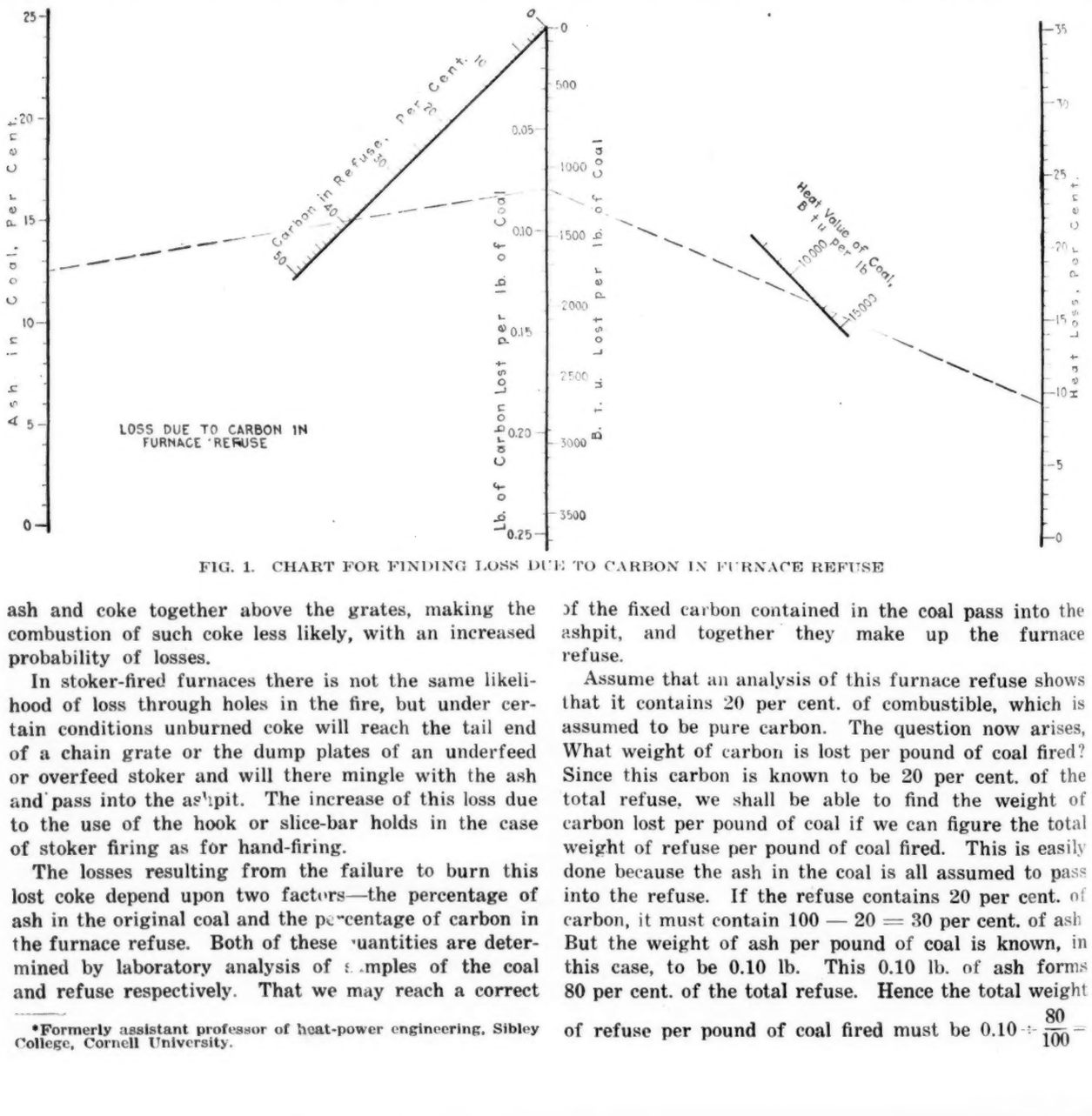
Ash in Coal, Per Cent.
Carbon in Refuse, Per Cent.
Lb. of Carbon Lost per lb. of Coal
B. t. u. Lost per lb. of Coal
Heat Value of Coal, B t u per lb
Heat Loss, Per Cent.
LOSS DUE TO CARBON IN FURNACE REFUSE

FIG. 1. CHART FOR FINDING LOSS DUE TO CARBON IN FURNACE REFUSE

Assume that an analysis of this furnace refuse shows that it contains 20 per cent. of combustible, which is assumed to be pure carbon. The question now arises, What weight of carbon is lost per pound of coal fired? Since this carbon is known to be 20 per cent. of the total refuse, we shall be able to find the weight of carbon lost per pound of coal if we can figure the total weight of refuse per pound of coal fired. This is easily done because the ash in the coal is all assumed to pass into the refuse. If the refuse contains 20 per cent. of carbon, it must contain 100 — 20 = 30 per cent. of ash. But the weight of ash per pound of coal is known, in this case, to be 0.10 lb. This 0.10 lb. of ash forms 80 per cent. of the total refuse. Hence the total weight of refuse per pound of coal fired must be $0.10 \div \frac{80}{100} =$

*Formerly assistant professor of heat-power engineering, Sibley College, Cornell University.

$\frac{0.10}{0.80} = \frac{1}{8}$ lb. The weight of carbon lost is 20 per cent. of this, or $\frac{0.10}{0.80} \times 0.20 = 0.025$ lb.

Putting this computation into general terms to apply to any numerical case, we have

Per cent. ash in refuse=100—*Per cent. carbon in refuse*

and

$$\textit{Total weight of furnace refuse} = \frac{\textit{per cent. ash in coal}}{100} \times \frac{100}{\textit{per cent. ash in refuse}} = \frac{\textit{per cent. ash in coal}}{\textit{per cent. ash in refuse}} = \textit{pounds of refuse per pound coal}$$

The weight of carbon lost is then

$$\textit{Pounds of refuse per pound of coal} \times \frac{\textit{per cent. carbon in refuse}}{100} = \frac{\textit{per cent. ash in coal}}{\textit{per cent. ash in refuse}} \times \frac{\textit{per cent. carbon in refuse}}{100}$$

This may just as well be written:

$$\textit{Pounds of carbon lost per pound of coal fired} = \frac{\textit{per cent. ash in coal}}{100} \times \frac{\textit{per cent. carbon in refuse}}{100 - \textit{per cent. carbon in refuse}}$$

Now let us compute the heat lost per pound of coal. One pound of carbon has a heating value of 14,600 B.t.u., so that the heat lost due to unburned carbon in the refuse will be

$$\textit{Pounds of carbon lost per pound of coal fired} \times 14{,}600 = \textit{B.t.u. lost per pound of coal fired.}$$

The percentage heat loss will be

$$\frac{\textit{B.t.u. lost per pound of coal fired}}{\textit{Heating value of the coal as fired}} \times 100.$$

These formulas have been combined in the alignment chart given in Fig. 1, in which the left half gives the pounds of carbon lost per pound of coal and the B.t.u. lost per pound of coal, for given values of the percentage of ash in the coal and the percentage of carbon in the refuse. The right half of the chart gives the per cent. of heat loss from the known result found from the left half of the chart together with the known heating value of the coal.

An examination of the chart will indicate that the extent of this heat loss may be considerable. For example, if we fire a coal containing 12.5 per cent. of ash, and if the resulting furnace refuse contains 38.7 per cent. of carbon, the weight of carbon thus lost will be 0.079 lb. of carbon per pound of coal fired. This results in a loss of 1160 B.t.u. per pound of coal fired. If the heat value of the coal is 12,700 B.t.u. per lb. this heat loss will be 9.2 per cent. of the heat value of the coal, which is the basis used for figuring all the heat losses in the furnace, boiler and setting. It can readily be seen that for higher percentages of carbon in the refuse this loss may be an even larger proportion of the heating value of the coal. It should also be noted that a higher ash content of the coal, with the same percentage of carbon in the refuse, will also give a larger heat loss. This is one reason, though a minor one, why high-ash coals do not permit as high boiler efficiencies as obtainable with higher grades of fuel.

Since this heat loss is by no means negligible, it is worth while to consider means for its reduction. From the discussion of the causes of this loss one important means of reduction is obvious—avoid all unnecessary barring and raking of fires, whether hand or stoker fired. Of course, working the fires with the hook or slice-bar is unavoidable at times, but such treatment of the fires should be reduced to the least possible.

Another means of reduction is to maintain conditions such that material passing to the ashpit will have an ample supply of air while it is still at high temperature. With hand-fired furnaces of the usual type little can be done in this line, but when shaking or dumping grates are used, care should be exercised to make sure that the material shaken or dumped is as free from combustible as it is possible to keep it. To make this easier, a layer of ash should be carried under the active part of the fire bed. This will give the additional benefit of protecting the grate bars against excessive temperatures. In the case of stoker firing much depends on the type and design of stoker. In the chain-grate type the speed of travel, the thickness of fuel bed and the air supply can all be controlled more or less completely. The ideal adjustment would be such that the ash is completely burned out just as it reaches the tail end of the grate. This would leave no portion of the grate covered by dead ash and would give no loss of carbon in the asphalt. Such an ideal is clearly impossible in daily operation.

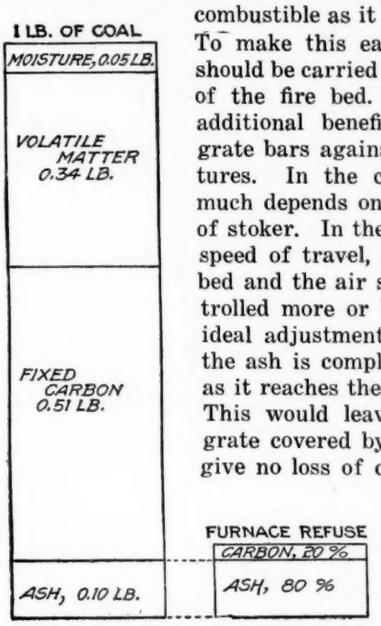

FIG. 2. CONSTITUENTS OF THE COAL

In the case of stokers equipped with dump plates or clinker grinders, the loss may be reduced by supplying air to the material lying on the dump plate or over the clinker grinder. There is, however, a distinct limit to the extent to which this can be carried, because there is grave danger that we may in this way supply a great excess of air to the furnace, thus increasing the volume (and hence the weight) of hot gases passing up the stack. This will increase the stack loss far more than any saving due to reduced carbon in the refuse. Hence this method of reducing the loss due to unburned carbon with the ash should be applied with caution.

A further objection to supplying too much air at the dump plate is that it may fail to effect any saving in the carbon lost, because the combustion of coke mixed with a large proportion of ash is a difficult matter. Too vigorous an air supply will simply cool this coke and put out any fire that may exist. The air supply should be just sufficient for the purpose and should flow gently through the bed of mixed ash and coke.

In this connection clinker grinders, as applied to several types of stokers, are a considerable help. When a dump plate is dropped, everything above it falls directly into the ashpit, from the bottom of the pile, which may perhaps be pure ash, to the top, which may consist to a large percentage of unburned coke. With the clinker grinder, on the other hand, material is constantly removed from the bottom only, leaving the upper part of the pile undisturbed. As this material slowly works its way down to the clinker grinder, it has ample time to burn out as completely as possible if an ade-

quate quantity of air is supplied. The heavy bed of hot ash serves to restrict the air supply, to preheat it before it strikes the burning carbon, and to reduce its velocity so that it is less likely to extinguish such coke as may be burning. In one series of tests with which the writer is familiar, the introduction of clinker grinders made possible a reduction of the carbon in the refuse from about 20 per cent. to less than 10 per cent.

The extent to which this loss may be reduced depends upon many things, but it seems that under fair operating conditions it is reasonable to expect not more than 20 per cent. of carbon in the refuse, and under good conditions not exceeding 10 per cent. The corresponding heat losses will then be less than 5 per cent. and may be as low as 1 per cent. under favorable conditions. A series of 77 tests conducted at the St. Louis plant of the United States Geological Survey showed an average heat loss a little under 5 per cent, and these tests were made under operating conditions, using coals of a wide range of quality.

Home-Made Oiling System

By John C. Kahl

When about to install an oiling system, as described herewith, first obtain two galvanized iron tanks such as are shown in Figs. 1 and 2. The drain tank and strainer, Fig. 1, should be placed in any convenient

FIG. 1. DRAIN TANK AND STRAINER

position below the level of the engine. It is provided with a cheesecloth strainer, held in place by a ring, into which the waste oil is discharged. After being strained, the oil drops to the bottom of the tank, where the impurities settle. The tank is provided with a gage-glass to indicate the height of the water and is drained through a pipe in the bottom.

The storage tank, Fig. 2, is suitably elevated, which can be done by fastening a couple of pieces of I-beam to the wall at such a distance from the roof as to allow the strainers to be easily changed. This tank is also provided with a gage-glass and is drained at the bottom. It contains two cheesecloth strainers, so that

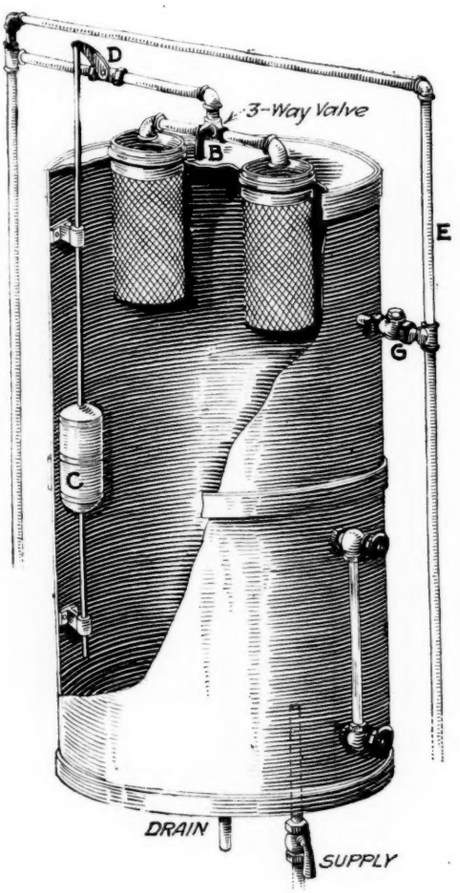

FIG. 2. STORAGE TANK AND STRAINER

one can be changed without interfering with the filtering of oil. A three-way cock *B* serves to change the oil from one strainer to the other.

In Fig. 3, upper left-hand corner, is shown a small plunger pump which may be so placed that a small connecting-rod can be attached to the rocker-shaft or other convenient part of the engine to give the proper stroke to the pump plunger. In the case of a Corliss engine it may be easily attached to the wristplate. The pump is preferably operated continuously while the engine is running. The suction pipe is run to the basement and enters the drain tank at *A*, Fig. 1. The discharge of the pump is run to the top of the storage tank, Fig. 2, where the oil is discharged into one of the strainers, the flow being governed by the three-way valve *B*. The height to which the oil can rise in the storage tank is governed by the float *C*, which will either open or close the butterfly valve *D*, as the height of oil requires. Should the float close the valve, the oil will continue to rise in the pipe passing over and down pipe *E*, which connects with pipe *F*, Fig. 1, entering the top of the drain tank.

In the event of disarrangement of either the float *C*

...r the valve *D* so that the latter does not close, the ...il, upon reaching the proper height, will flow through ...he overflow *G*, Fig. 2, which is provided with a check ...alve to prevent oil filling the tank when bypassing.

The supply pipe is connected to the bottom of the storage tank, the end of the pipe projecting into the tank, and is carried to the engine to be served, suitable smaller pipes being connected for supplying the various bearings.

An ordinary oil cup is used with this system (Fig. 3), the top being tapped at *H* for a ¼-in. supply pipe.

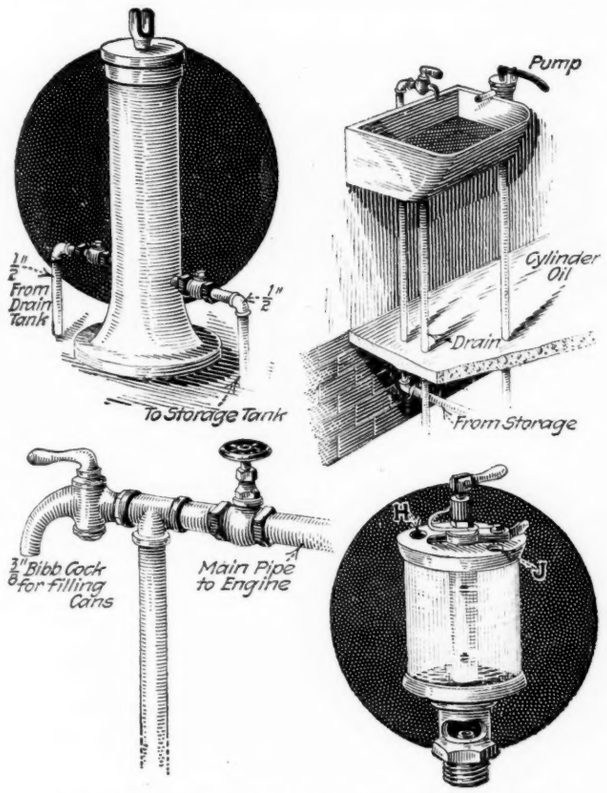

FIG. 3. PUMP, OIL CUP AND PIPING FOR FILLING HAND OIL CANS

The hole *J* represents the original filling hole, which is tapped for a ¼-in. plug. Should an accident occur to the oiling system, the plugs can be removed and the cup filled from an oil can.

A place can usually be provided in the basement for a cylindrical oil tank. A convenient outfit consists of a galvanized-iron oil sink (see upper right-hand corner, Fig. 3), equipped with a small hand pump, for drawing cylinder oil from the tank. A drain pipe from the sink discharges into the engine-oil tank in the basement. A pipe should be run from the engine-oil main supply pipe to the sink, where it is provided with a ¼-in. bib cock for filling oil cans, shown in detail at the lower left-hand corner, Fig. 3.

A recent British invention has been made whereby the piston of an internal-combustion engine may be cooled by means of a draft of air circulating through a space in the piston. The draft is provided by means of fan blades on the engine flywheel. On either side of the hollow piston are ports which register with corresponding ports in the cylinder walls at the end of the stroke. A draft of air is thus forced through the hollow space in the piston while all the ports are in line.

Reels to Prevent Conductors Kinking When Being Installed*

By Terrell Croft

Reels should be used for carrying the coils of wire that is being pulled into a conduit. It is most important that this direction be followed where a number of conductors are being drawn into the same tube. The reels prevent kinks and tangles. The

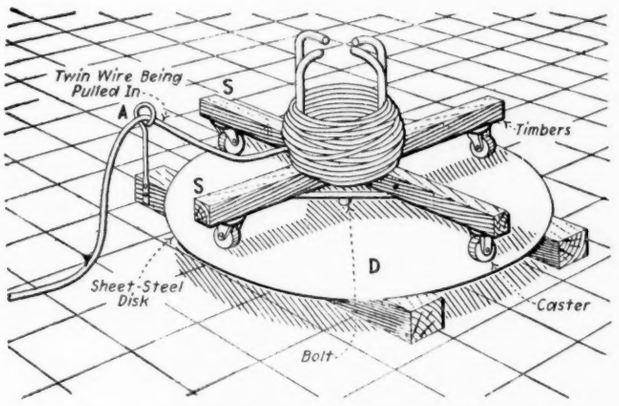

FIG. 1. EASY-RUNNING TWIN-WIRE REEL

time that they save much more than justifies their expense. A single-coil reel may be made as illustrated in Fig. 1. It comprises two cross-sticks *S* fastened together at their center and rotating on a bolt. Casters are attached to the ends of these pieces so that the

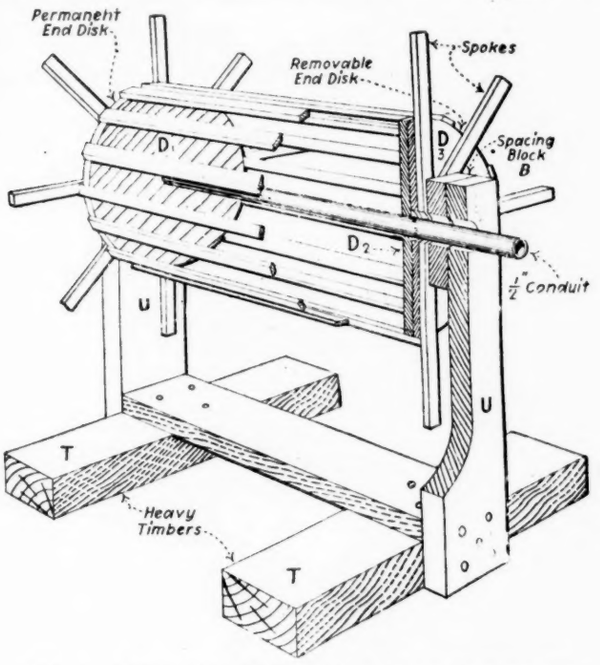

FIG. 2. REEL FOR CONDUCTORS THAT ARE BEING PULLED INTO CONDUIT

reels will rotate readily. The sheet-iron disk *D*, resting on two timbers, provides a smooth track on which the reels can run. A stationary guide arm *A*, through which the conductor being drawn in is passed, tends to prevent the reel from turning when the wire is not being drawn off and minimizes twisting and kinks.

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*Copyrighted, 1919, by Terrell Croft.

A wooden reel which may carry one or more coils may be constructed as in Fig. 2. The slats ($\frac{1}{2}$ x 1 x 20-in.) comprising the cylindrical portion of the drum are nailed to two disks, D_1 and D_2, which are about 12 in. in diameter and $\frac{7}{8}$ in. thick. Spokes ($\frac{7}{8}$ x $1\frac{1}{2}$ in.) are fastened on D_1. Disk D_2 is made removable and also has spokes attached to it. The axle is a piece of $\frac{1}{2}$-in. conduit passing through $1\frac{1}{8}$-in. holes. The spacing block

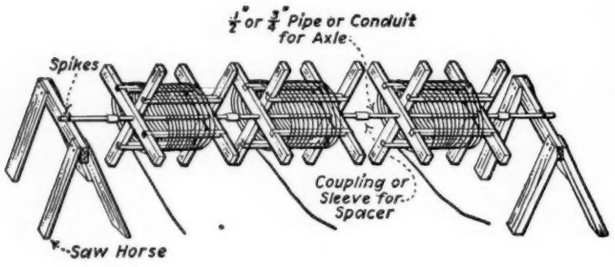


FIG. 3. MULTIPLE REEL FOR THREE COILS

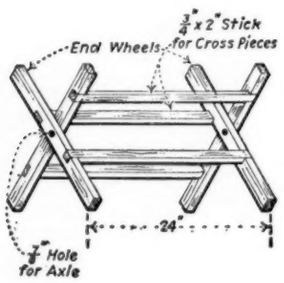


FIG. 4. WIRE REEL UNIT ASSEMBLED

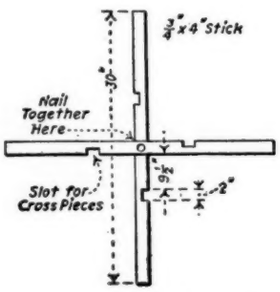


FIG. 5. DETAILS OF END WHEEL FOR REEL FIG.

B can be removed to allow taking out risk D_2. The uprights U are 2 x 6-in. pieces. Timbers T and T, which are heavier than is necessary for mechanical reasons to prevent tipping, constitute a base. When mounting a coil of wire, the reel is taken from the frame and the removable disk D_2 drawn out. Where two wires of the same diameter are to be pulled in, the coil is divided into two approximately equal portions and one portion

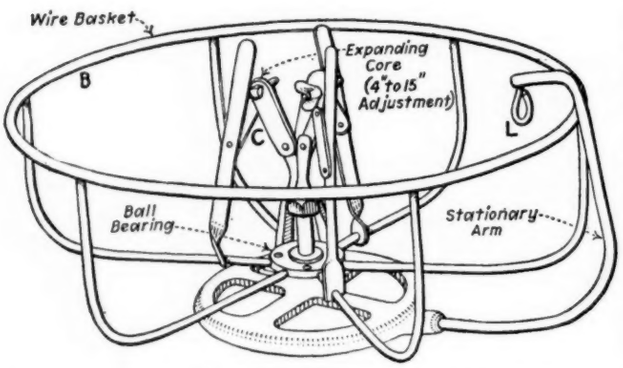


FIG. 6. METALLIC WIRE REEL TO PREVENT KINKING

is reversed. Then both are slipped over the reel. When more than two conductors are to be drawn in simultaneously, additional coils can be mounted on the cylinder as required. Then the cylinder is remounted in the frame and the conductors are ready for pulling into the conduit.

A multiple-reel arrangement, Fig. 3, may be readily assembled. The supporting axle, which is a length of $\frac{1}{2}$-in. or $\frac{3}{4}$-in. conduit, is sustained by two sawhorses. Couplings or nipples which will slip over the axle are used as spacers between the reels to prevent interference. Each component reel is made as suggested in Fig. 4. The end wheels are detailed in Fig. 5. One end wheel of each reel should be held in its reel with wood screws, so that it can be removed readily to provide for the mounting of a coil of wire.

The reel shown in Figs. 6 and 7 is constructed entirely of metal. The coil of wire rides in a basket B and is held in position by an expanding core C. The reel turns on a ball bearing, which renders oiling unnecessary. The wire is fed out through a loop L, on a stationary arm. Hence, when pulling ceases the reel automatically brakes itself. It is made in two stock sizes of 12 in. and 24 in. outside diameters. The weights are 6 lb. and 12 lb. respectively.

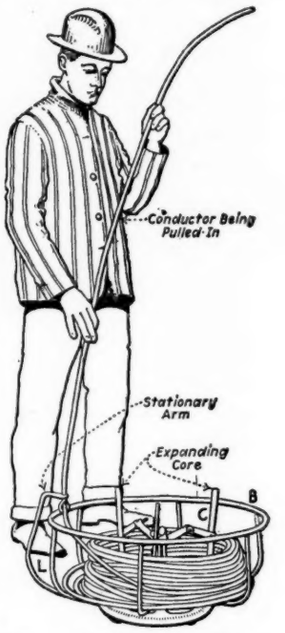
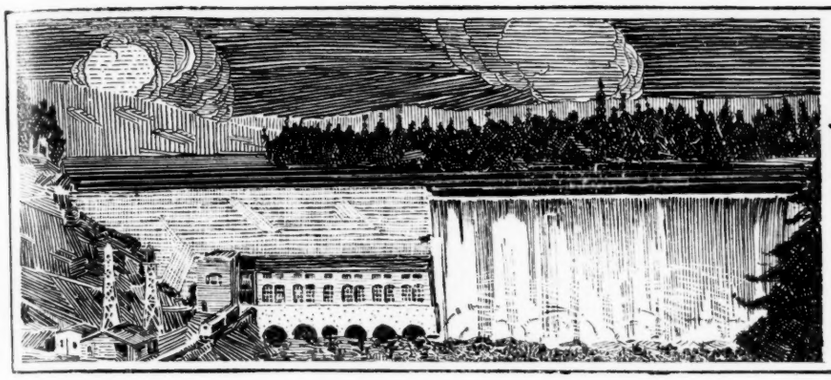


FIG. 7. WIRING REEL IN USE

Danger of High-Potential Currents

Employees should be taught that high-potential currents are dangerous to life, and they should know the voltage carried by every conductor in their station or under their supervision, says *Electrical Safety Magazine.* They should be instructed that not only the bare conductor but the insulation as well, on high-voltage conductors, should not be touched or closely approached. A wire insulated for and carrying a potential of 110 volts, might be, and is, reasonably safe to handle; but the same or similar wire, carrying a potential of 1000 volts, although to all appearances perfectly insulated and harmless, would be extremely dangerous to handle, and the higher the voltage the greater danger to life.

It cannot be too often repeated or too strongly impressed upon all the employees that insulated, as well as bare, cables or wires carrying high potentials are dangerous to handle or approach, unless they are inclosed with a grounded metal sheath. Insulation on high-tension conductors gives a sense of false security to the uninstructed, and many serious accidents to employees have occurred because a conductor was thought to be safe because it was insulated. It is the old story of "Didn't know it was loaded." Electric current at high potential will jump from a conductor through some insulation, and it is not necessary to make actual contact with a high-voltage conductor in order to receive a fatal shock. This matter of not placing too much dependence as far as personal safety is concerned on the insulating covering of wires is often neglected in the instruction of new men, and it is something that should be thoroughly explained and understood by all operators and linemen.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"BROADLY speakin'," said Pop, after he and Jimmy had found a table in Casey's Grill and Cabaret, "they is only two settin's for a turbine. One is what you call 'inside gate mechanism' an' the other 'outside gate mechanism.' In the first type the water comes in contact with all the gate-regulatin' apparatus, an' which I call inside gate-regulatin' mechanism, and in the other the gate levers, links, etc., are protected from the water."

"What determines whether the setting will be inside

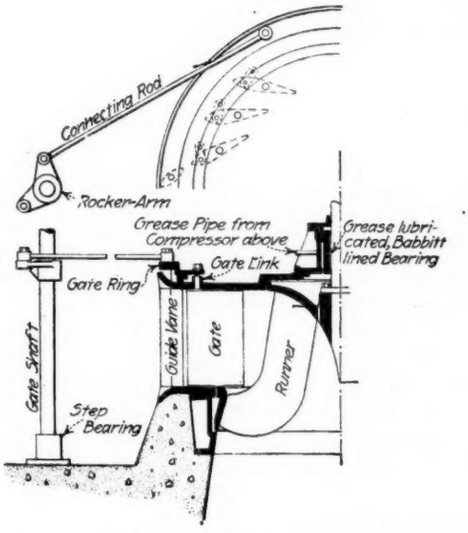


FIG. 1. INSIDE TYPE OF GATE REGULATION

or outside? Is it a question of cost or the hobby of the engineer?" asked Jimmy.

"Both, although a turbine of a given type with inside gate-regulatin' mechanism will cost about 25 per cent. less than the same machine arranged for outside gate control. Some engineers claims the water acts as a lubricant, an' they tells of a big Pelton-wheel plant out West on the far side of the Truckee, with somethin' like 12-in. bearin's that only used water for a lubricant an' been runnin' fine for ten years. It's true that water is a lubricant, to a certain extent, but I don't think you can beat oil at it. The water that circulates around them gate links an' other things on the turbine is often fulla sand an' fine silt that might jes' as well be an emery wheel workin' on them parts. An' as for the outside gate mechanism, it can't be denied that the silt does git into the packin' on them gate stems an' keeps on scorin' right along. An' the fact that you have packin' on the gate stems to keep the water out increases the friction the governor has to work against; although if there is silt an' mud around the gate connections, as it usually is in the inside type, I don't see that they is any more friction in the outside type than they is in the other. Fig. 1 shows the inside type of gate riggin' an' Fig. 2 the outside type as it is usually set in a concrete penstock. The parts is all named for your convenience. This type of settin' is usually called the open-flume type.

"In plants where the head is much over 50 ft. another type of mountin' is used. Here the turbine may often be put in a steel case an' may have the water comin' in from a pipe line on the end, top or side of the case. Then they often puts the turbine into a steel or cast-iron casin' made into a spiral shape, an' while both of these last-named types may have inside or outside gate mechanism, the outside is mostly used. Fig. 3 shows the spiral-case arrangement of outside mechanism. Now in most any of these settin's the shaft may be arranged either vertical or horizontal, the horizontal

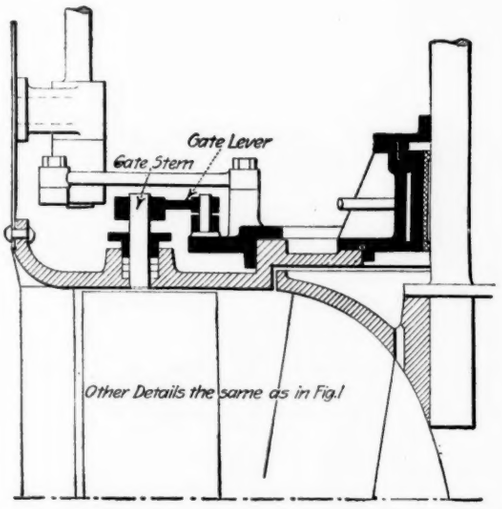


FIG. 2. OUTSIDE TYPE OF GATE REGULATION

not bein' as efficient as the vertical, especially on low-head plants."

Now as to the kind of bearin's on these units. When it is necessary to put the bearin's in the water, they is gen'ly made of lignum-vitæ wood shaped in blocks about like that shown in Fig. 4. Sometimes in very cheap turbines the blocks is made of oak, but oak swells a lot more than lignum-vitæ an' is likely to grip the shaft. Some engineers pokes a good deal of fun at the idee of a vegetable bearing, but the lignum-vitæ stands up

pretty well, cases bein' quite common where the wood has only worn down a sixteenth of an inch in about five years. Them screws is intended for adjustin' the pressure of the blocks agin the shaft an' is gen'ly made of brass. For small shafts like gate shafts it is common to line the bearin's with babbitt an' depend on the water fer lubrication."

"On vertical-shaft turbines how do they support the generator rotor and the heavy shafting, to say nothing of the runner? That stuff must be pretty heavy, Pop."

"Yep, it is. They most gen'ly uses roller bearin's, as engineers has been bit quite a few times on ball bearin's, prob'ly on account of the balls bein' too small, etc. In the early days it was quite common for balls to crush to a powder an' scratch up the ball races pretty bad before they could stop the generator unit. Some engineers prefers bearin's of the disk type an' they is some pretty fine bearin's of that kind, the Kingsbury style in partic'lar."

"Have roller bearings ever gone to powder like the ball bearings you just spoke about?"

"Roller bearin's has squashed up kinda bad already, seemin' to freeze if not properly lubricated. That's one fault of disk bearin's as well."

"That makes me wonder how they stop those big units when they have to—real quick."

"Brakes is usually furnished with such turbines, about like I shows in Fig. 5, consistin' essentially of two steel beams with brake faces bolted to them an' with some arrangement of toggle action to apply the pressure. On some units where the rotatin' masses ain't too great an' where the specified time for stoppin' ain't very short, some firms uses oak or maple blocks; but I considers wood to be dangerous, 'cause the brakes might seize for some reason or other an' then the thing takes fir. The usual time for stoppin' is from three to five minutes. If you jes' shut down the unit an' didn't apply the brake, the thing would prob'ly continue to run for fifteen or twenty minutes.

"They has been some attempt in Europe by Swiss and French engineers to use hydraulic brakes, the principle bein' of a paddle wheel keyed to the turbine shaft an' rotatin' in a closed vessel fulla water, an' under normal runnin' conditions the water bein' drained out. The paddle wheel is made of a sufficient number of plain disks, punched with a dozen or so of pretty big holes

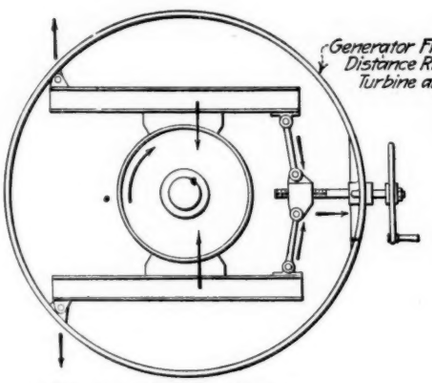


FIG. 5. TOGGLE-ACTION BRAKE

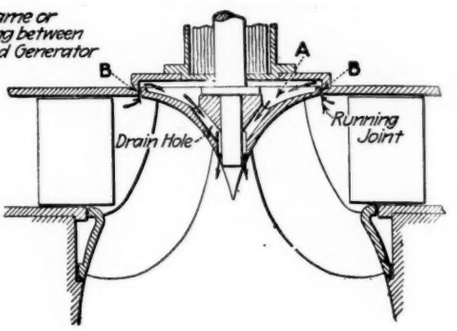


FIG. 6. DRAIN HOLES FOR CLEARANCE SPACE

so that when not bringin' the unit to a stop they rotates in air an' don't do much fannin' 'cause the disks has no projections to fan the air with."

"That would do away with the tendency to heating up so much, wouldn't it? But there's somethin' else on my mind, Pop, left over from our last talk. Why did you show some holes in the runner hubs, and what are they for? Make me a sketch and tell me all about it," said Jimmy, eagerly.

"Oh, I know what you mean. Them holes is for drainin' the water out of the clearance space—the water that leaks in around the running joint. Jes' hand me that paper there to make you a drawin' on." Pop rapidly sketched Fig. 6. "That water, if allowed to remain there, would build up a pressure in the space *A*, 'cause it rotates with the runner, the same principle as the centrifugal pump, an' puttin' a whole lotta extra load on the thrust bearin'. In a runner of the type shown, the pressure would amount to about one-third the head in feet times the area inside the runner band at *B* if they was no drain holes there. With the holes the pressure is relieved about 20 per cent. The area of them holes should be about five times that of the runner clearance to do much good, an' even then some engineers insists on havin' drain pipes provided from this space to the draft tube to make sure that the pressure is relieved."

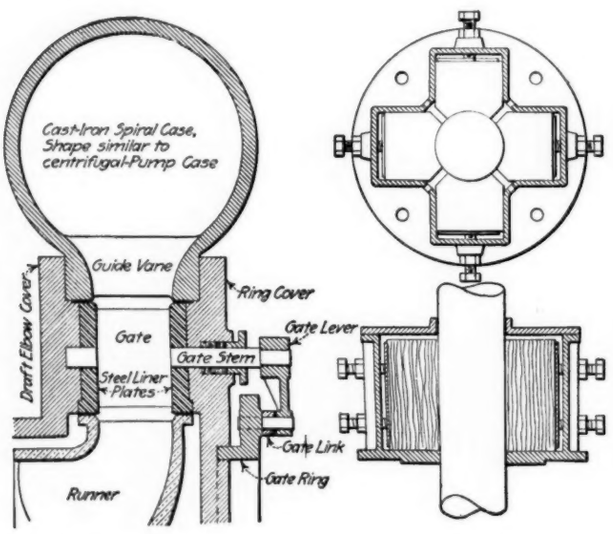


FIG. 3. SPIRAL CASE OUTSIDE ARRANGEMENT OF GATE REGULATION

FIG. 4. APPLICATION OF LIGNUM VITÆ BLOCKS

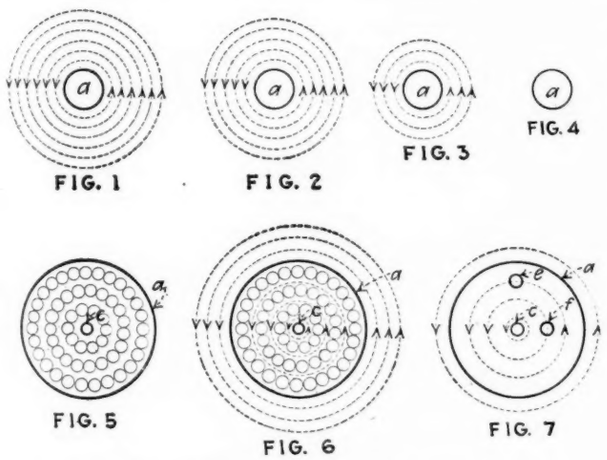
According to the *Electrical Review*, London, large schemes for the development of electric power, with high-tension transmission, are in progress or being worked out in the Dutch Colonies, one of which will develop 30,000 hp. There is undoubtedly a large future for all classes of electrical machinery in these sections. German competition has entirely ceased for the time being, and the natural source to obtain the machinery for these developments from will be Great Britain, America and Holland.

The Electrical Study Course—Properties of Alternating-Current Circuits

It is shown how inductance in an electric circuit is caused by the magnetic field set up about the conductors when current is flowing in the circuit. Hydraulic analogies are used to explain the effect.

WHEN a load is connected to a source of alternating voltage it is found that the value of the current that flows is dependent upon something besides the resistance of the load; namely, two other factors known as inductance and capacity.

Inductance is a property due to the magnetic field set up around a conductor whenever a current flows through it and the disappearance of the field when the flow of current ceases. Thus, let *a* in Fig. 1 represent the cross-section of a conductor in which current is assumed to be flowing up out of the surface of the paper. The magnetic field will surround the conductor as indicated by the dotted circles, and the direction of the field will



FIGS. 1 TO 7. REPRESENTS THE ACTION OF THE MAGNETIC FIELD ABOUT A CONDUCTOR

be in a counterclockwise direction as shown by the arrow-heads. Suppose now, that the current is gradually decreased to zero. The field around the conductor will then decrease until it disappears, as illustrated in Figs. 2, 3, and 4.

The conductor *a* may be considered made up of many small conductors, as indicated in Fig. 5, and surrounded by a magnetic field when current flows through it. For example, the central conductor *c* would be surrounded by a field represented, in Fig. 6, by the dotted circles. If the current in the entire conductor be slowly decreased, the field around *c* will shrink, and as the lines of force contract they will cut across each of the other conductors. When conductors are cut by a magnetic field, an electromotive force is set up in them. In Fig. 6 the direction of the electromotive force would be up out of the surface of the paper. This will be understood from Fig. 7. The field cuts the conductor *e* from the upper side to the lower, which is equivalent to making the conductor move upward through the field. Applying the right-hand rule for the direction of voltage, it is found that the electromotive force developed is, as stated, out from the surface of the paper. Likewise the electromotive force in any other conductor, such as *f*, will be found to be also toward the reader. Consequently, when the field of *a* in Fig. 1 begins to shrink as in Fig. 2, an electromotive power is set up in

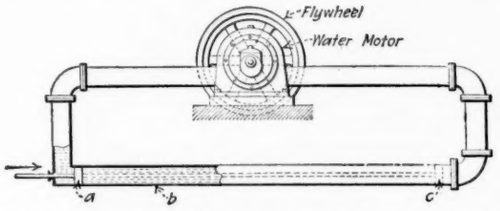


FIG. 8. HYDRAULIC ANALOGY OF INDUCTANCE

a which is in the same direction as the current that is flowing through the conductor. Hence, the effect is a tendency to keep the current flowing.

Suppose now, that after the current has been decreased to zero it is again gradually increased. Then the field will begin to expand, and it will therefore be moving in the opposite direction to that when it was decreasing. The electromotive force generated in *a* will then be in the opposite direction to that when the current was diminishing—namely, away from the reader—therefore will oppose the flow of the current and retard it. An expenditure of energy is required to produce this retarding force, and this energy is stored up in the revolving magnetic field. When the current decreases, the stored energy is given back, and it is the source of the force that tries to keep the current flowing, as described in the preceding paragraph.

This action of the magnetic field may be considered as a flywheel effect, such as would be obtained in a hydraulic system, similiar to that shown in Fig. 8, where piston *a* is arranged to move backward and forward in a long cylinder *b* the ends of which are connected through a water motor driving a heavy flywheel. When the piston is moved from left to right water will be caused to flow through the system and set the motor in motion. However, due to the inertia of the flywheel the motor will be slow in coming up to

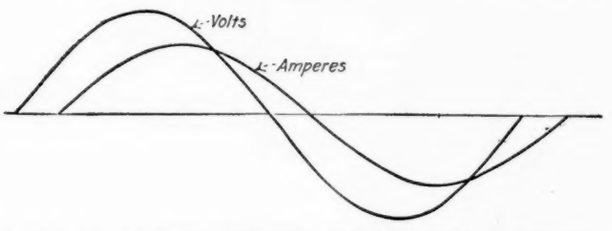


FIG. 9. CURVES SHOWING THE CURRENT LAGGING BEHIND THE VOLTS

speed, and will offer considerable more resistance to the flow of the water than if the flywheel was used. When the motor reaches a constant speed corresponding to the flow of the water, the effect of the flywheel will be practically negligible and the water will flow through the motor at a rate equal to that as if the flywheel did not exist. However, when the piston approaches the end of the cylinder and begins to slow down, the fly-

wheel will keep the motor running and the latter will supply power to the piston to keep it moving to the right, just as the decaying magnetic field about a conductor will set up a voltage in the circuit to keep the current flowing when it is decreasing in value. It is evident, from Fig. 8, that the effect of the flywheel is to retard the flow of water when the latter is increasing in motion and to maintain the flow when it is decreasing in value. This is just the effect of the magnetic field on the flow of the current in the circuit, as pointed out in the foregoing. The result of the flywheel effect in an alternating-current is to cause the current to lag behind the volts, as shown in Fig. 9. In other words, the maximum value of the current occurs an instant later than the maximum value of the volts and the current reaches zero value an instant later than the volts.

In Fig. 1 the magnetic field constitutes the revolving flywheel that was set in motion in Fig. 8, when the current of water began to flow. When the current begins to decrease, this magnetic field gives up its energy and causes the current to continue to flow for a short space of time. If the flow of water in Fig. 8 is continued long enough for the pump to reach its normal speed, then, neglecting friction, as already pointed out, the water will flow through the motor almost as freely as if it were a piece of the pipe line. If, however, a rapidly reciprocating pressure is applied to the piston the flow of water cannot be very great, and no matter how often the operation be repeated, no great volume of water can be made to flow. Similiarly, in Figs. 1 and 4, if the voltage in *a* be increased and decreased rapidly, the flywheel effect of the magnetic field will retard the flow of current; the more rapid the changes the smaller will be the current that can be caused to flow for a given applied voltage. When the current is an alternating one, the changes are very rapid, consequently, if the flywheel effect is great, the current will be very small. This flywheel effect is called

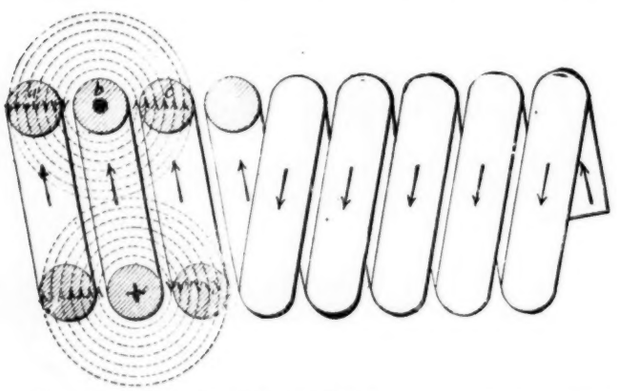


FIG. 10. REPRESENTS ACTION OF MAGNETIC FIELD IN A COIL

the inductance, or reactance, of the conductor. Since the reactance of a circuit causes a reduction in current, its effect is similar to that which would be caused by resistance. For this reason reactance is usually expressed in ohms, and is represented by the symbol X.

The reactance of a single straight conductor, such as *a* in Figs. 1 to 4, is very small. If, however, the conductor be wound into a coil, as illustrated in Fig. 10, its reactance will be greatly increased. The lines of force from a single section, such as *b*, will be cut by all the other sections, such as *a* and *c*, so that the total flux cut by the conductors will be greater than for a single conductor. If an iron core is inserted within the coil, the magnetic flux will be greatly increased thereby and the reactance will be correspondingly greater, since more flux is cut by the conductors.

If it were possible to have a circuit containing reactance only, we could find the current flowing through

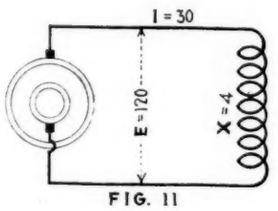


FIG. 11

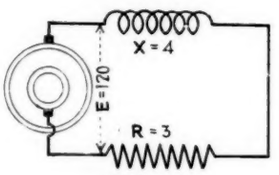


FIG. 12

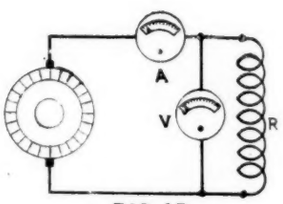


FIG. 13

FIGS. 11 TO 13. DIAGRAM OF ALTERNATING-CURRENT AND DIRECT-CURRENT CIRCUITS

it from the formula $I = \frac{E}{X}$ just as in the case of resistance we use the form $I = \frac{E}{R}$. Thus in Fig. 11, let X be a reactance of 4 ohms and E be 120 volts, then $I = \frac{E}{X} = \frac{120}{4} = 30$ amperes. From this we might readily draw the conclusion that if we had a circuit such as that in Fig. 12, containing both reactance and resistance, as most all alternating-current circuits do, we could find the current by adding the reactance to the resistance and dividing into the voltage, thus: $I = \frac{E}{X + R}$, giving as a result $I = \frac{120}{4 + 3} = 17.1$ amperes. Such a conclusion, however, is not true; the current would have a value quite different from that so obtained.

Assume in Fig. 13 that a coil of wire R is connected across a direct-current circuit containing a voltmeter V and an ammeter A. If the voltmeter reading is 115 and the ammeter reading is 20. the resistance of the coil is $R = \frac{E}{I} = \frac{115}{20} = 5.75$ ohms. However, if this same coil is connected on a 115-volt alternating-current circuit, it will be found that less current will flow through it than on the direct-current circuit. Assume that the ammeter on the alternating-current circuit registered only 11.5 amperes. In this case the volts divided by the amperes would give what might be considered the apparent ohms, or, as it is called, the impedance of the circuit. Impedance is represented by the symbol Z. In the problem in question the impedance $Z = \frac{E}{I} = \frac{115}{11.5} = 10$ ohms.

In a direct-current circuit this would be 10 ohms resistance. However, on an alternating-current circuit it is made up of two factors: Ohmic resistance, which we found to be 5.75 ohms, when connected on a direct-current circuit, and a second factor—the reactance of the circuit. At first thought the conclusion might be

arrived at that the impedance Z minus the resistance R would give the reactance in ohms; that is, $10 - 5.75 = 4.25$ ohms. However, this is not the case, as already pointed out. The reason for this is that in an alternating-current circuit the applied volts act as though they were divided into two parts at right angles to each other; one used to cause the current to flow through the resistance of the circuit, and the other to overcome the inductance; that is, the two have the same relation as the volts in a two-phase system. Consequently the resistance ohms and the reactive ohms

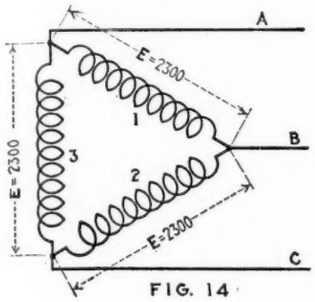


FIG. 14

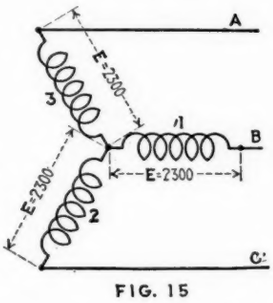


FIG. 15

FIGS. 14 AND 15. DELTA-CONNECTED WINDINGS AND "Y"-CONNECTED WINDINGS

must be considered 90 deg. apart. Where we know the resistance ohms R and the impedance ohms Z the reactive ohms $X = \sqrt{Z^2 - R^2}$. In this problem $X = \sqrt{10^2 - 5.75^2} = \sqrt{100 - 33.0625} = \sqrt{66.9375} = 8.18$ ohms.

The voltage necessary to overcome the resistance of the alternating-current circuit is $E_R = I \times R = 11.5 \times 5.75 = 66.125$ volts, and the voltage required to overcome inductance is $E_X = IX = 11.5 \times 8.18 = 94.07$ volts. As stated in the foregoing, the voltage required to overcome resistance and that to overcome reactance act as though they were two separate voltages in the circuit 90 deg. apart as in a two-phase circuit. Consequently, to get the resultant volts E necessary to overcome the resistance and inductance of the circuit, add the component volts in a 90 deg. phase relation, or $E = \sqrt{E^2_R + E^2_X} = \sqrt{(66.125)^2 + (94.07)^2} = 115.02$ volts against 115, which we assumed the voltage of the circuit to be. In the next lesson the effect of reactance upon the power transmitted in a circuit will be considered.

One of the problems in the last lesson was to find the voltage per phase of a system connected to a three-phase generator having three separate windings each generating 2300 volts, if the windings are connected delta, also when connected in "Y." For delta connection the windings would be arranged as in Fig. 14. The voltage across AB would be that of winding No. 1, that across BC the voltage of coil 2, and that across AC the voltage of coil 3. Since the voltage of each winding is 2300 volts, the three voltages of the system would each be 2300 volts.

When the generator coils are connected "Y," as shown in Fig. 15, the voltage across AB will be the resultant voltages of coils Nos. 1 and 3 combined, which is equal to $2300 \times 1.73 = 3984$ volts. The voltage across BC is that of coils Nos. 1 and 2 combined, and that across AC of coils Nos. 2 and 3 combined, both of which give the same result as already found; namely, 3984 volts.

A third question was to compute the maximum value of an alternating voltage that indicates 220 volts on a voltmeter. The voltmeter reads the effective value of the voltage, and *the maximum value = effective value* $\div$ 0.707, in this problem equals $220 \div 0.707 = 311$ volts.

Two hundred and forty amperes flows through a coil of wire when connected across a 120-volt direct-current circuit, but when connected on 210 volts alternating current 300 amperes passes through the coils. Find the ohmic resistance R, impedance Z, reactance X in the coil, volts necessary to overcome the resistance and the reactance volts.

Belt Selection and Installation

BY J. FRED ENGLER

When buying belting for any drive it is always well to bear in mind a thorough appreciation of the fact that the measure of the value of a belt is the efficient and satisfactory service it gives. The purchaser of a belt buys service. Service bears little relation to the initial cost. The belt that gives the most efficient and satisfactory service for the money invested is the most economical.

But since the value depends on service and service depends on so many factors, the selection of the best belt for any drive requires an intimate knowledge of the characteristics of each drive, of the belting available for it and of the integrity of the manufacturer of that belting.

The efficiency of transmission is measured by the load carried without slip or excess tension. This depends largely on the continuously efficient coefficient of friction. The friction coefficient of new belts is easily determined and has been established with a fair degree of accuracy for the various beltings in the market. But the frictional coefficient of new belts cannot be accepted as the continuously effective coefficient of friction.

Under clean conditions, with proper treatment the effectiveness of certain classes of belts increases with use; in others, under the same conditions, it decreases with more or less rapidity. Under usual mill conditions with dirt, dust, oil, steam, etc., the original frictional coefficient is soon destroyed or changed. The continuously effective coefficient of friction under actual working conditions can be determined only by close observation and regular and frequent tests.

Tensile strength, durability, pliability and resistance to atmospheric changes are important factors for consideration. Belting deficient in any of these essential qualities is neither efficient nor economical.

A belt should remain pliable to the last hour of service to secure that close pulley contact so essential to effective transmission. A stiff, hard belt has very little effective pulley contact without excessive tension. Some belting shrinks or stretches with every change of the barometer or may be breaking tight in the morning and so loose at noon that it fails in duty. Belts of this kind are expensive in lost production and lost power.

Most belt users are rather positive in their ideas regarding the kind of belting they think is best adapted to their work. If these ideas are the result of numerous actual tests, they are well founded and sound, but if they are reached through guesswork, tradition and prejudice, they may be mighty expensive. Most makers of good belting are more anxious to have their best belt used for a drive that will stand for service than to simply sell a belt. Belting that is sold on a service basis is a safe investment.

Before placing a belt see that the shafting and pulleys are in alignment and that the pulleys are well balanced as to both relative and individual size. Endless belts run smoothly and give satisfactory service provided the lacing is properly done and the belts are closely watched while in service.

It is a mistake to punch lace holes. A belt awl should be used to force the fabric apart, retaining as much of the original belt strength as possible. Belts generally fracture at the lace holes. There is a general tendency to use a large lacing. The strength of a laced joint increases as the number of lace holes increases and the size of the holes decreases. A swing joint gives the best transmission on small pulleys.

Of the numerous metal fasteners on the market those that penetrate without cutting the belt and leave the least exposed metal on the pulley side of the belt are the most desirable. In applying a metal fastener care should be taken so as not to start a fracture either in the belt or the fastener.

Having used every effort to select the best belt for the drive and install it properly, keep a record of its performance consisting of the average horsepower transmitted, the slip, the tension, the time lost for repairs, the repair cost and the length of service, with remarks on causes of failure and any item of interest relative to belt transmission. This is the only way in which a detailed knowledge of transmission costs can be secured. This knowledge, aside from being a matter of satisfaction, will be a potent factor in rectifying many mistaken ideas regarding belt transmission and in the reduction of transmission costs. Where such records are kept, there is no market for inefficient belting at any price.

Nugent Automatic-Alarm Oil Filter

A dirty oil filter is a useless device. As the filtering bags fill up with accumulations of sediment and dirt, the capacity of the filter gradually diminishes until its output of cleansed oil is far below the rate of dirty-oil inflow and the filter becomes flooded and overflows or the supply of freshened oil to the lubricated parts becomes less than the requirements.

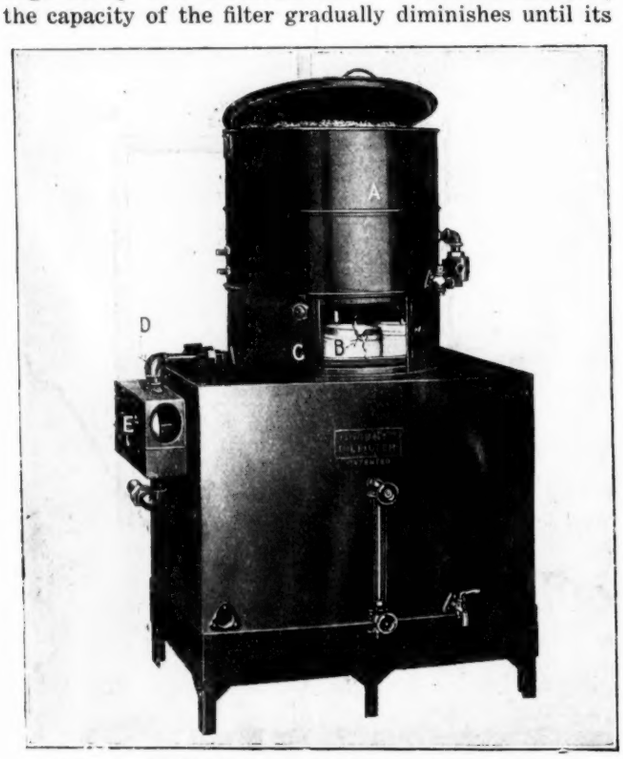


FIG. 1. NUGENT AUTOMATIC-ALARM OIL FILTER

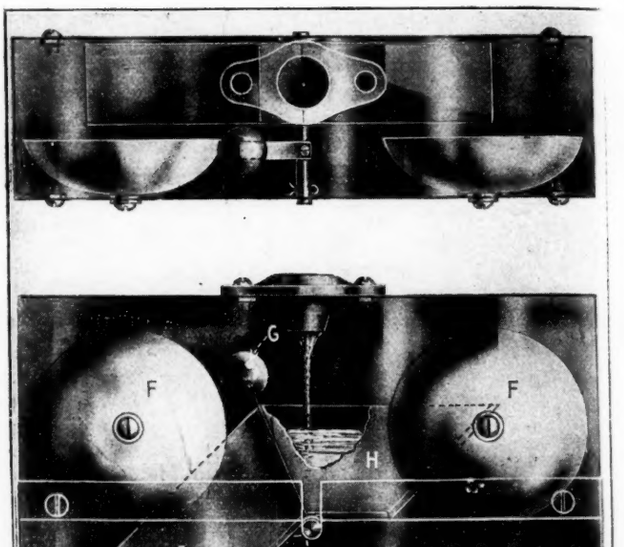


FIG. 2 DETAILS OF DIRTY-OIL ALARM MECHANISM

Hitherto the only way in which to forestall such trouble was to make periodic inspections. If inspections were forgotten or if the accumulations of sediment and dirt became unexpectedly rapid, trouble developed anyhow. With the purpose of doing away with this danger, W. W. Nugent & Co., 150 West Superior St., Chicago, Ill., have developed an automatic-alarm filter. The filter, Fig. 1, is the standard apparatus put out by this concern and was described in *Power* for Jan. 1, 1918. The automatic-alarm feature is shown at *E* and a detail in Fig. 2. The dirty oil from the receiving chamber *A* feeds into the standard triple filtering bags as shown. The holding rings of these bags are made with an overflow spout, shown at *B*, which discharges into the trough *C*. This trough connects with the outlet pipe *D*, which in turn discharges into the alarm box *E*.

Referring to Fig 2, the alarm mechanism consists of a tilting two-compartment tank hinged at *J*, two gongs at *FF* and a beater *G* which moves with the tank. When the compartment *H* fills to a given level, the tank becomes overbalanced and tilts to the right, whereupon the beater comes in smart contact with the right-hand gong *F*, sounding the alarm. The overflowing oil then discharges into compartment *I* until it in turn becomes overbalanced and sounds a second alarm upon the left-hand gong *F*. This cycle is repeated until the needed attention is given the filter and the bags cleaned.

When one bag only is overflowing, the interval between alarm signals may be, say, one minute. When the second and third bags begin to overflow, the interval between alarm signals becomes shorter and the alarm more insistent.

By a simple modification the alarm box can be connected with electrical mechanism so that a buzzer or bell located anywhere about the plant can be sounded to give warning. Or, if desired, a light can be flashed to serve the same purpose.

EDITORIALS

Operating Engineers of the Future

THE development which steam power has passed through has brought about radical changes not only in plant equipment, but also in the duties of the steam engineer. The early power plant was what might be termed a steam-mechanical outfit. The plants for the most part were so small that the engineer was usually the fireman, oiler, engineer and mechanic combined. If this individual of many jobs was a good mechanic with a stout arm and a willingness to work hard, he generally proved to be what was considered a good engineer. If he lacked in these qualifications, the plant and equipment suffered accordingly. Fuel was cheap and it was of little concern to the management whether a horse-power hour was produced on five pounds of coal or twenty—the one thing of prime importance was to keep the plant running. Even though this engineer might have wished to operate his plant in an efficient manner, there were few devices available to afford him an intelligent understanding of the actual conditions in the boiler and engine room.

Approximately one hundred years after Watt succeeded in making the steam engine applicable to the driving of all kinds of machinery, the first commercial electrical generator was put into service. This epoch-making event may be considered the beginning of the economical generation and transmission of power, and with it the operating engineer's profession began to take on a new aspect. By the use of the voltmeter and an ammeter it was possible to ascertain the load on the station at any time. This soon created an incentive to know what was required to produce this load, and then there gradually followed a development of boiler-room instruments which now form a part of every up-to-date plant.

In addition to the electrical equipment the engineer is often in responsible charge of heating and ventilating apparatus, refrigerating equipment, air compressors, etc., all of which may be driven by steam engines, steam turbines or electric motors. To meet these added responsibilities he has found it necessary to broaden his knowledge and develop his executive ability.

In considering the super-power systems, which are being talked about so much, the operating engineer may be led to question his future and to ask what he can do to prepare himself to meet the new conditions. The best answer is to acquire a broader knowledge of things electrical. Where pumps, compressors, etc., are now driven by steam, in the future they will be driven electrically, but they will always require the same intelligent care and even more than the steam-driven equipment. The need for economy in keeping down power consumption will be just as great as with steam equipment. Instead of these problems characteristic of the steam equipment, there will be load adjustment to keep the maximum demand to a minimum, adjustment of the power factor, etc., all of which call for intelligent handling.

The Busy Season in the Power Plant Begins

THE fall and winter seasons, with their short, cold days and nights, mean much to power-plant men. The electric-lighting load and heating load increase throughout the twenty-four hours of each day. The equipment should be ready for it.

For refrigerating plants these seasons bring relief, as the load in nearly every plant drops enough with the coming of cool weather to permit of shutting down part of the station to make necessary repairs, cleanings and inspections. Now is the time to be ready to renew badly worn parts, rebore compressor cylinders, clean condensers and evaporating coils, and renew or grind in leaky valves.

While the plant is down or partly down for such work, the time is opportune to make such changes in piping and connections as experience throughout the season or over the years has shown necessary or desirable. The engineer who has this work laid out to be done in convenient sequence and according to a schedule is a man with foresight. Too often, work of this kind is thought about a great deal, yet when the time comes when it should be done, the crew or the chief engineer of the plant is unprepared, and without good reason.

We have in mind a large hydro-electric station where there are many main units and where the station load is high and continuous. Inspections and maintenance work are done according to schedule. A chart having rectangles representing every piece of apparatus or large parts of machines, such, for example, as main unit governors, is hung in the chief operator's office; the chart covers a period of one year. As each inspection and repair or renewal is made, the rectangle representing the part or machine is filled in with colored ink. A fully inked-in rectangle signifies a completed job. If the job is but half finished, the rectangle is but half colored. The inspection and maintenance charts, together with the yearly work schedule, insure not only that the work goes on smoothly and on time, but that no vital part is overlooked. While such provisions are too elaborate for the small plant, their success demonstrates that more intelligent planning of inspections, repairs and maintenance in small plants would avoid many of the breakdowns and emergencies that occur to them. Now is the time for the refrigerating engineer to complete his plans and schedules for the low-load winter season.

Presumably, every man responsible for a steam-heating system has taken advantage of the summer and now has everything ready for the load so soon to come. Radiator-valve stems should be packed, also the pumps; additional radiating surface should now be ready for use in rooms where too little surface brings discomfort to occupants and annoyance to the engineer. Air valves, invariably a source of aggravation, should by now have been overhauled. These are but a few of the details about a heating system, which must

function well if the service is to be a credit to the engineer in charge.

Generally speaking, for all but refrigerating plants, the engineer who has not taken advantage of the warm, low-load season to put his plant in the best possible condition for the season's run will likely have reason to regret it before the winter season is over.

Power-Supply Problems

CONFRONTED by a threatened fuel shortage due to decreased production, with the consequent necessity of eliminating inefficiency in the power supply, the British government has recently sponsored an "Electricity Supply Bill." This aims to place the whole matter in the hands of a commission which, acting through district boards, would control all the electric systems throughout England. As originally drawn the bill contained many drastic features, but later amendments aim to coördinate rather than eliminate many of the existing systems and would tend to conserve the experience of those who have been intimately associated with these systems rather than place them in the hands of political appointees.

This recognition on the part of the British government, of the vital importance of cheap and adequate power as fundamental to healthy industrial progress, recalls the attempt last winter of Secretary Lane to secure an appropriation for a power survey in this country. Although the proposal had the unqualified support of the engineering profession, it failed to sufficiently impress Congress and suffered the fate of the water-power and other well-merited bills in the filibuster that occupied the closing days of the session.

The Secretary evidently recognizes the futility of having the bill reintroduced at the present time, but the subject is too important to be set aside and warrants immediate consideration as soon as Congress has disposed of its present foreign-relations problems. But it will receive consideration only in proportion to the active support given it by engineers in general.

Who Is Responsible?

FOR months past there has been standing idle at Muscle Shoals, Alabama, a sixty-thousand kilowatt power plant complete in every respect and representing the best practice that skilled engineers could lay down. This installation forms part of the great nitrate plant that was to turn out nitrates by the ton for our vast explosives program, and was described in our March twenty-fifth issue.

The armistice came before the plant got into production, although the construction was carried to completion, the big turbo-generator turned over and then, after a short time, the operating crew departed and watchmen were placed in charge.

This plant was designed for the production of nitrates by the cyanamid process, and it is claimed that, with slight additional expenditure, it could be converted for the production of fertilizer for which the farmer is now required to pay such exorbitant prices. This is aside from the enormous idle investment represented.

Who is responsible? Is it the War Department or is it Congress, or, perchance, just Government inertia? It has been said that the Government has not the talent to operate the plant and is unwilling to turn it over at the figure offered by the company that would have operated it had the war continued. In any event, to have this costly equipment idle is a large and needless economic waste.

In a paper on "The Isolated-Plant Costs, as Influenced by the War," presented at the twelfth annual convention of the Pennsylvania Electric Association, this statement is made: "A study of a number of isolated-plant cases developed the fact during the year of 1919 we (central stations) would have been required to reduce rates 22.1 per cent. to secure the business of the cases studied, whereas in 1918 we could have increased our rates 46.9 per cent." Apparently, this is an admission that the cost of central-station service could not meet that of many isolated plants until after 1916 and no doubt accounts for the fact that so many of the latter withstood the efforts of the former, prior to this time, to shut them down on sound economic principles.

In a recent address M. O. Leighton, chairman of the National Service Committee, ascribed much of the inefficiency in Government departments to the enlargement of Federal activities without regard to their proper coördination. The result is that numerous bureaus, whose work is of an engineering character, are attempting to function within departments that have little or no relation to the work in hand, and the heads of these departments are frequently required to pass upon matters of a technical nature. The bill now before Congress providing for the creation of a Department of Public Works aims to remove these misplaced bureaus and place them all within the one department, which would be organized on engineering lines.

During the first week of October Harvard graduates will undertake a nation-wide drive to secure an eleven million dollar unrestricted endowment for the university. It is the intention to devote a large share of the income from this endowment to increasing the salaries of the professors and instructors. The present scale, although comparable with those of other large universities, is so low as to make it difficult to hold the teaching organization together. This condition is typical, and because the incomes of the universities have not kept pace with the expenditures, the relief is necessarily in the hands of the alumni. Others might well emulate the example of the Harvard alumni.

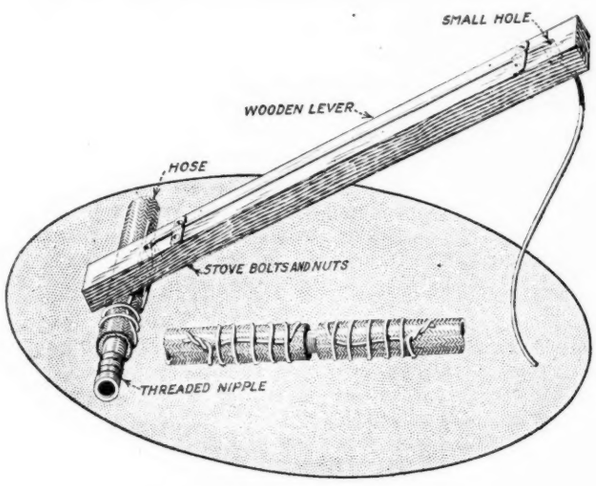
Under the caption of "An Editor's Ignorance" the *Black Diamond* takes issue with our editorial of July twenty-second, on the coal situation. We frankly admit ignorance of much that goes on within the inner circles of the coal industry; if we knew more it would make very interesting reading for the large number of consumers that we reach weekly.

American engineers have become accustomed to a steady increase in transmission-line voltages, but the jump from 150,000 to 220,000 volts in California is a step that does credit both to the boldness of the promoters and the skill of the designers.

Correspondence

Repairing Hose Leaks

In a certain plant they have a neat and effective method of repairing leaks in steam or water hose. They use a hardwood lever about 2 x 2 x 15 in. long with a ¼-in. hole bored through it at each end, as shown in the illustration. Then about a No. 14 wire



TOOL FOR WIRING HOSE JOINT

is put through these holes and held in place by two metal clips that are attached to the lever by stove bolts and nuts; these hold the wire taut or loose as desired.

The hose to be repaired is cut, at the leak, and a threaded nipple of the correct diameter is inserted in the hose. Then with the aid of a vise and a pair of pliers a neat joint can be made by using the lever as shown.

J. A. LANDOLINA.

Memphis, Tenn.

Packing Cage Sections Gripped Packing Rings

I once took charge of some large double-acting gas engines, and beside numerous other difficulties, I found that the operating force had been and were having trouble with the water-cooled piston rods running hot at the point where they worked through the packing cages.

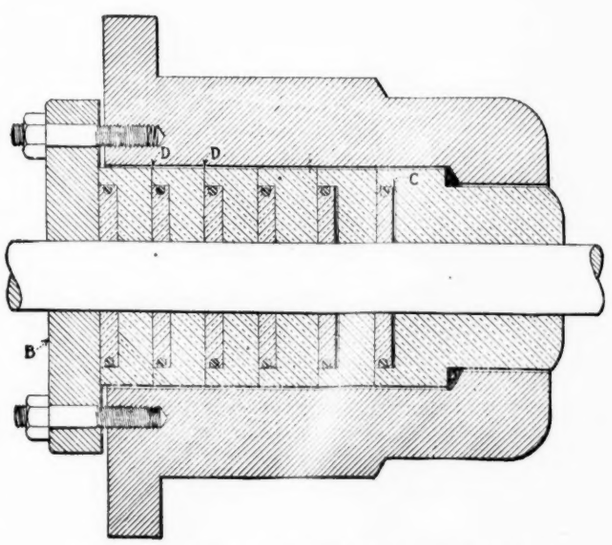
This statement may sound exaggerated, but I stood on the switchboard gallery and saw one of those rods with a place on it as big as my hand, red hot, and when they got in that condition, there was nothing to it but to pull them off, run slowly a while until the rod cooled down, stop, pull out the packing cage, file the rod smooth (if it wasn't warped so bad as to be beyond any further use), put in new packing and try again.

The practice had been to pull the packing cage out on the rod, take the sections of the cage apart, hook the new garter spring around the rod, assemble the sectional packing ring between the spring and the rod, slide the next section against it, put in the No. 2 ring, and the next packing cage section against it, and so on until all the rings and sections were assembled.

The illustration shows the construction of the packing cage. There were four long studs (not all shown), which screwed into the flange bottom, passed back through all the sections and the flange *B* with nuts on the outer ends to hold the sections together. It was noticed when the repair men were putting the cages back in place that if the four nuts were pulled up tight the cage was hard to push on the rod, and an investigation was immediately started.

It developed that the sections had been ground together so much that the width of the ring recesses had been so reduced that it was narrower than the ring was wide, thus following the ring to be clamped between the sections, as shown at *D*, *D*.

No stuffing-box could be expected to work this way, and as there were several old cages around the plant, the sections were taken from these, put in the lathe, and the ring recesses deepened so that the packing ring had about $\frac{1}{64}$-in. side clearance as shown at *C* in the figure.



PACKING RINGS PINCHED IN PACKING CAGE

After this, the packing cages were assembled on the floor with the rings in place and care taken that the rings were free to move after the nuts on the long studs had been pulled down as tight as they could be pulled. It is needless to say that we had no more hot rods from this cause.

EARL PAGETT.

Cherryvale, Kan.

Influence of Air Density on the Pneumatic Type Steam-Turbine Governor

Referring to the type of steam-turbine governor, described on page 300 of the Aug. 19 issue of *Power*, it will be evident that a change in density of the air due to changing atmospheric conditions within the turbine room may cause a slight change in speed of the turbine. This, however, in practice is found to be negligible. For a better understanding of this condition, refer to the accompanying chart, which shows the change in density of the air due to a change in temperature, humidity or barometric pressure.

The temperature line is based on a barometer of 30 in. and a relative humidity of 65 per cent. which is approximate for this investigation; any other basis would simply show a parallel line. The humidity line is based

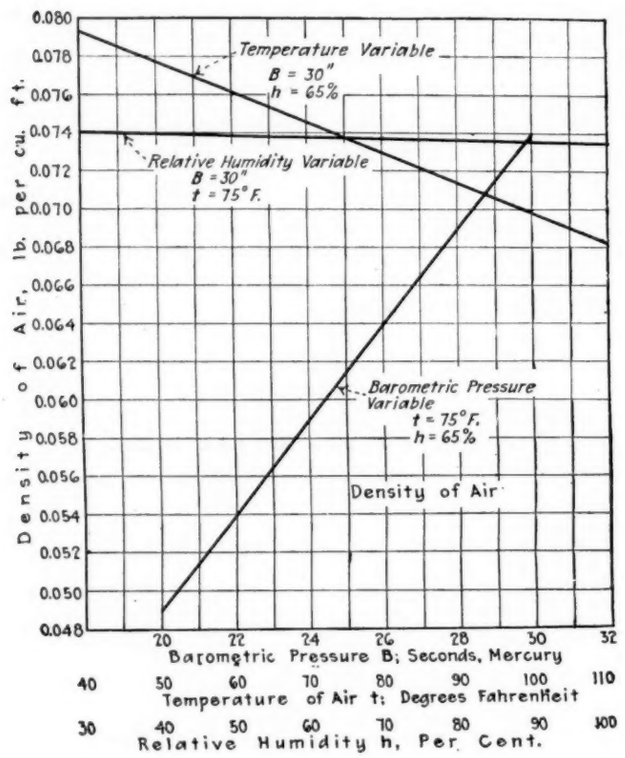


CHART SHOWING CHANGE IN DENSITY OF AIR DUE TO CHANGE IN TEMPERATURE, HUMIDITY OR BAROMETRIC PRESSURE

on a barometer of 30 in. and a temperature of 75 deg. F.; any other basis would give a parallel line. The atmospheric pressure or barometer line is based on a temperature of 75 deg. F. and a relative humidity of 65 per cent.; any other basis will give a parallel line.

The change in density of the air may be read from the vertical scale for a change of any one of these properties of the air, viz., barometer, temperature, or relative humidity. In the operation of such a governor, the air pressure generated by the fan is proportional to the density of the air and to the square of the speed

A change in barometer reading of say 1 in. from 28 to 29 in. (which is considerable and would be over several hours' time), would mean a difference in density of about 0.0024 lb., per cu.ft., that is a change in density of about 3.47 per cent. Since the pressure change is as the square of the speed, by extracting the square root of 3.47 we have 1.8 per cent change of speed. With the provision for speed adjustment this is easily taken care of. Furthermore, as stated, a 1-in. change of barometer is about the extreme range of change in most localities and this rarely occurs except over 24 hours or more of time.

The humidity line shows there is so little change in density, due to any possible change in humidity, that it is negligible.

A change of temperature in the engine room of from say 80 to 100 deg. F. will cause a difference in density of 4 per cent., the square root of which is 2 per cent possible change of speed. Such a change in temperature rarely occurs in an engine room and can easily be adjusted for if necessary, as it will always be over a considerable period of time, and is therefore unimportant. Only the make-up leakage of air past the pistons requires to be replaced by the fan, and in fact with this construction it is possible to return the leakage air to the suction of the fan, or to conduct the air from a point not subject to considerable variation, to the intake of the fan.

Actual service shows that any change in air conditions which occurs in an engine room has no effect of any consequence on the operation of these governors. The figures taken for illustration are extreme, and therefore not applicable under normal conditions.

THOMAS HALL,
Mechanical Engineer, Ridgway Dynamo & Engine Co.
Ridgway, Penn.

From a Woman Chemist

I read with interest an article in your issue of Aug. 26, page 332, entitled, "Coal Analyses made at the Power Plant," and especially the introductory statement, which reads: "A method which obviates the necessity for sending coal to a chemist and gives accurate results promptly. The work can be done by a woman and apparatus costing $300."

Being a woman and in charge of the research laboratory of a paper mill, I am especially interested in the line of reasoning by which you or the author of the article arrived at the estimate of women implied in the quotation. Perhaps you might be interested to know that there were three years ago fifty women registered as having received Ph.D. degrees in chemistry in the United States and that there is a large army of them with B.S. and M.A. degrees, and various practical experiences whose proven skill would justify their resentment of the foregoing statement.

In employing the partly trained help, I much prefer women because they more quickly arrive at an understanding of the problem back of the test and the more easily become efficient chemists with an ample supply of general information on the engineering side of the industrial chemist's position. Indeed, whenever we have had coal samples to test here, we have given the work to a girl chemist, because we have not yet installed a calorimeter and the girls more easily learned the more difficult combustion analysis.

Altogether, my experience and knowledge would lead me to resent the implication in the sentence quoted, I should be interested to know whether your experience does justify it, or whether the sentence slipped through by mere accident.

JESSIE E. MINOR.
Garfield, N. J.

Chain Arrangement for Gage-Glass Cocks

I would like to suggest a method of installing chains on the quick-closing valves of water columns that I have found of advantage in keeping the glass in working order. Although these valves are installed primarily for the purpose of shutting off the boiler pressure while renewing the water glass, they can be easily made to assist in keeping themselves clear and free from obstructions.

CHAIN CONNECTIONS

Referring to the sketch, connect a chain to each end of the lower lever *D* as is usually done. Then instead of connecting the arms *C* and *D* by short chains direct, connect the left or opening side of the top lever *C* to the chain from the lever *D* at a point *A*, about 12 in. below the lever *D*. Connect the chain from the right, or closing side of lever *C* to the chain from the lever *D* near the bottom of the loop, as at *B*, within easy reach of the operator.

The idea is this: The upper cock *C* contains steam and the lower cock *D* water; incidentally the top cock seldom gets stopped up, whereas scale, etc., in the water frequently stop up the bottom cock. Now, in case of a stoppage of the lower cock for example, it is only necessary to close the top cock by means of its individual chain, and with full boiler pressure behind it almost any obstruction in the bottom cock can be blown out by opening the usual column blowdown valve or cock.

In blowing down a water glass with both top and bottom quick-closing valves open the steam flows through the upper valve and tends to balance the pressure on the lower valve, consequently the effective pressure tending to blow obstructions out of the lower glass is quite low.

I have found that the ordinary obstruction in either valve can be easily removed by closing the opposite valve and blowing down the glass, whereas it would not respond to the ordinary method of blowing down the column with both top and bottom connections open at the same time.

Water columns, as a rule, have a tendency to stop up, probably because the radiation from them cools the water contained and precipitates some scale. Then also the openings to the glass itself are small and a piece of scale or rubber gasket will shut off the circulation, especially in the lower connection.

Where no valves are provided in the water-column connections to the boiler, this method of connecting the chains will be found extremely useful. Many engineers are opposed to valves in such connections, and have good reason to be, because of the careless method employed in handling boilers by some firemen. In a case of stoppage and no valve in the connection it is necessary to cut the boiler out of service and relieve it of all pressure, before the column can be examined. The suggested method of connecting the chains to the quick closing valves will reduce this trouble to a minimum.

New York City. WARREN D. LEWIS.

Was Caustic Soda Responsible?

A noncritical or hasty reading of the article entitled "Rear Head of Steam Drum Fails," on page 70 of the issue of July 8, and the editorial entitled "Was Caustic Soda Responsible?" on page 71, might leave the impression that this accident was due to the presence of caustic soda in the boiler water.

We have collected considerable information on this subject, and there appears to be a probability that a high concentration of caustic soda may embrittle steel plates under certain conditions, as for example, steel tanks or drums in which caustic soda is concentrated or stored. But the evidence so far collected does not seem to be conclusive nor does it prove that cencentration of caustic soda such as would occur in water treated by the usual softening methods would be harmful.

Finally, according to your own statement in the last paragraph of the editorial, you have no evidence that the water used in the Newmarket boiler contained caustic soda, so why intimate that this was the cause of the explosion? G. H. GARRISON.

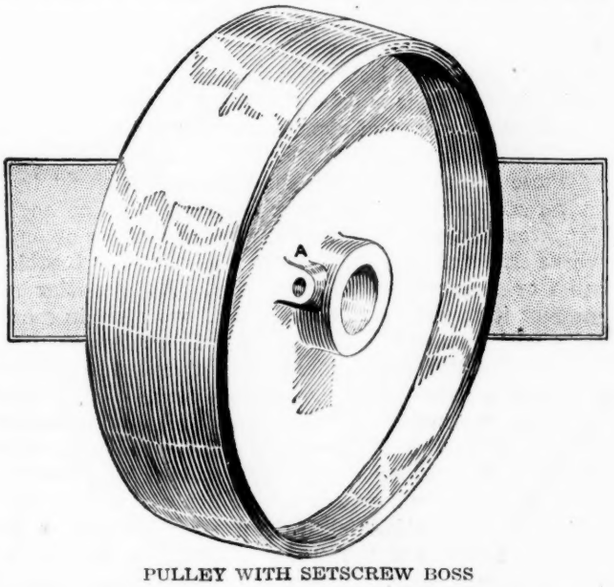
New York.

[The boiler in proximity to the leak was covered with a white deposit, and the fracture was such as has characterized previous failures traceable to this cause. —Editor.]

Small Pulley Setscrews

Small cast-iron pulleys are usually screwed to the shaft by means of a setscrew through the hub. After short usage the threads usually strip and frequently the hub will split, rendering the pulley useless.

Before having such a pulley cast, it would be easy to attach a boss to the pattern as shown at *A* to give



PULLEY WITH SETSCREW BOSS

a greater length of thread and to prevent the hub splitting. Care must be taken to allow room to insert the screw between top of boss and rim, unless a headless screw is used and inserted through a hole in rim.

If the pulley runs at such a high speed that a boss on one side would cause vibration, two opposite bosses could be cast on to balance each other.

Oakland, Calif. H. H. PARKER.

Pulverized Fuel for the Railways

My attention has been called to an article in the June 24 issue of *Power*, under the title "Pulverized Fuel for the Railways," the same being an abstract and comment on the report of the committee on pulverized fuel which was presented at the International Railway Fuel Association meeting in Chicago during the week of May 19.

There are a few things in this report upon which I believe a little more authentic or reliable information could be presented, in view of the fact that among the reports quoted there was such a wide difference of opinion and of results obtained.

In regard to the information from the third source, it mentions that "the only difficulties were with the drying, pulverizing and handling of the coal and also the danger in connection with it." The only reason we can see for mentioning these items as difficulties is that the committee that made this report either had a very poorly designed and equipped pulverizing plant for their model or else their source of information is rather limited in so far as the burning of pulverized coal in locomotives is concerned. The drying, pulverizing and handling of the coal is no more difficult than at the present time with hand-fired locomotives, and in fact less actual manual labor is required from the time the coal is dumped from the cars until the time it is loaded in the locomotive tender, and it is common practice in large pulverized coal plants to run the drying and pulverizing equipment 20 to 24 hours a day.

As all the coal which passes through the pulverizing plant is crushed down to uniform size before being pulverized, it is evident that no trouble or stoppages can occur in the transporting system due to large lumps, etc. Again, as the coal, after being pulverized, is passed directly into water-tight and air-tight storage bins, there can be no trouble whatever from moisture in damp weather or freezing in winter weather, and it is then as easy to coal the locomotive tender as it is to fill the water tank, as this is done through a canvas spout.

Notation is made of the old time-worn expression of the "danger in connection with it." Years of experience of those familiar with its use prove conclusively that pulverized coal, when properly handled, is no more dangerous than lump coal, either on locomotives or anywhere else, and in some respects it is even less troublesome or dangerous than lump coal. As a matter of interest it might be noted here that we have in more than one instance loaded pulverized coal which was afire from a storage bin into a locomotive tender. This coal was smoldering or burning so rapidly that you could not see inside the tank on account of the smoke after loading the coal therein. After the coal was loaded in the tender the top of the tank was simply closed up tight and within a few hours the CO_2 generated entirely extinguished the fire and no trace of it could be found, and the coal could then be burned in the regular manner. In fact it can be burned immediately after placing in the bin while still afire if so desired, and we have often done so with no trouble whatever.

In regard to the paragraph which says "the tendency of explosion and spontaneous combustion which is always present in coal of this character should be eliminated entirely if possible to do so." In reply to this it can be stated absolutely that the tendency of explosions have been practically eliminated in modern plants such as now designed and built, and in so far as the coal carried on a locomotive is concerned this is entirely harmless as it is carried in bulk in an air-tight tank, and therefore there is no tendency for dust to rise and blow around where it could be ignited. In regard to the elimination of spontaneous combustion it is a fact that we have never known this to occur in a locomotive tank no matter how long the coal had been stored, and it can also be prevented in storage tanks by simply making sure that they are air-tight, as the coal will not burn without sufficient oxygen.

We fail to see how any specially designed furnace, especially on a locomotive, could be constructed which could burn coal ground to the fineness of granulated sugar in suspension. An instant's thought will show that this is rather an impossible supposition when the fact is taken into consideration that the air passing through a locomotive firebox travels at such a high velocity that the entire contents of the firebox are replaced in from four to six times a second, and coal pulverized to the fineness of granulated sugar unless it were gunpowder or something similar would certainly be deposited against the flash wall or in the bottom of the combustion chamber before it would be half consumed, and it of course would then only be a matter of a short time before the whole firebox was filled up. The only way it could be kept in suspension in a firebox such as on a locomotive, would be to carry such a terrific draft that it would be carried over the arch and through the flues before it would be half consumed, and of course then the efficiency would be nil.

In regard to pulverizing coal on tenders of locomotives, this would certainly be a very undesirable feature in our opinion, as the apparatus necessary for pulverizing coal to the proper fineness must be quite heavy and strongly constructed, and the space and weight it would occupy on the tender would be out of all proportion to the work done. Certainly nothing is more simple than to run a locomotive under a tank or bin of ready pulverized coal as at present, open a valve, and in a few minutes have a tank of perfectly dry pulverized coal. It is as simple as filling a tank with water.

It certainly is not the intention of the railroads if they adopt pulverized coal to have it prepared at a central pulverizing plant and have it transported to other parts of the system for use, any more than it is for the railroads to have coal bunkers at one point and then transport the coal in cars hundreds of miles where they have no bunkers to coal locomotives for hand-fired use. There would have to be pulverizing equipment at each large coaling terminal.

There is one objection which the committee have not noted in regard to conducting experiments at the test plants of large universities with pulverized-coal fired locomotives; that is, that in running over the road the coal in the tank of a tender becomes quite firmly packed from the constant pounding and vibration. This brings up a condition in regard to feeding which could be hardly duplicated at a test plant, as one of the essential features of a pulverized-coal burning equipment on locomotives is that there must be a constant steady feed to the firebox at all times, for as there is hardly more than a pound of coal in the firebox at any instant it can be readily seen that the least interference with steady feeding would very quickly affect

the steam pressure and steaming qualities of the locomotive. In other words, apparatus which worked out very nicely on a locomotive when standing still or around the yards, proved to be wanting in a good many things when it was taken out on the road, due mainly to the action resulting from the packing of the coal in the tender.

In regard to the matter of "not enough having been said about cash balances but only fuel economy," the main trouble here is that on all the railroads where experiments with pulverized coal have been conducted, only comparatively small pulverizing plants have been used and naturally cash balances cannot be offered in this case as evidence, as the cost of pulverizing the coal does not approach an interesting figure until large amounts are pulverized in commercial plants, such as from 100 to 1000 tons daily. These cash balances can be obtained, however, on absolutely reliable and authentic records from any number of plants which have been pulverizing coal daily for many years and in which correct records are kept of everything, including power, labor, depreciation, etc., from the time the coal is dumped from the cars until the time it is burned in the furnaces or boilers. For instance, pulverized coal can be prepared today in a thousand-ton-capacity plant for 36 cents per net ton. This cost includes power, labor, depreciation, interest, taxes and insurance, these based on the following figures:

Power at ¾ cents per kw.-hr. and allowing 13 kw.-hr. per net ton pulverized; labor at 40 cents per hour; coal for the drier at $5 per net ton delivered; repairs at 7 cents per net ton pulverized; interest at 6 per cent.; depreciation at 4 cents per net ton; taxes and insurance at 1.3 cents per net ton, making a total of 36 cents per net ton.

These figures are based on standard practice today in the average large coal pulverizing plant and would, of course, vary somewhat with local conditions, cost of labor, power, etc. W. D. Wood,

Locomotive Department, Fuller Engineering Co.
Allentown, Penn.

Low Pay of Government Technical Men

Recently, an article appeared in the technical press about the low pay of technical men in the Bureau of Standards, this pay being so low that a great many of the men had to resign and seek employment with private concerns.

From experience, if the Bureau of Standards pays its technical engineers any less than the Navy Department pays its men of the same ability, there is no formula by which both ends may be figured to meet and live. The Navy Department has lost, is losing and will continue to lose its best technical men on account of low pay, and I wish to say here, that the Navy Department has not considered the fact that it must pay the same salaries as private concerns if it wants to keep efficient men.

The Navy Department seems to think its technical men can live on promises, as it has promised to look into the matter of readjustment of wages of technical men—this in December, 1918, but up to July, 1919, no relief had come. If it takes this long to look into the matter, it will probably take several years to force itself to actually do anything in giving justice to the men in the department.

Now the technical forces have organized and affiliated with the American Association of Engineers, and let us hope that the A. A. E. will grow and raise the standard of engineers, as most every trade and profession has a standard, and if an employer does not meet the standard he will have to take the second rates.

There are engineers (civilian) working in these yards who command, outside, from $3000 to $7000 per year, but they worked for the Navy on account of the war for wages of from $5 to $8 per day, not even on a monthly basis, but per diem, like a laborer, and it stands to reason that these men cannot see their way clear to remain with the Navy Department.

It costs the Government about twice as much to do a thing as it does a well-managed private concern. Why? The answer is inefficiency, and inefficiency is in evidence at every turn in the navy yards. This could be remedied if the Government would take a few lessons from some of our large manufacturing concerns.

To show some of the Government inefficiency, Washington orders the various yards and stations to do certain minor things, which are not the proper things to do, but if any initiative is shown by the yard, and especially by civilian engineers, it is promptly sat upon at Washington. Washington does not allow each yard to handle these minor details as best suited for each and best known by each respective yard.

Norfolk, Va. A. W. Koiner.

Peening Stopped Leak

On page 233 of the Aug. 5 issue, A. Dolphin tells of stopping a leak in a 12-in. steam nozzle by peening. At one time I had three boilers working under 125 lb. pressure and a leak showed up on the steam nozzle at the threads. On examination it was found that the pipe was properly screwed into it. A ball-peen hammer was put to work on the inside, peening it out; the result was a permanent job and the leak was stopped. At another time the nipple to the safety valve began leaking at the threads. The piping was extra-heavy and this leak was peened out.

I have often stopped leaks around the threads in headers, and steam-pipe lines at the flanges by peening. I always make a tight job, although one should be careful not to peen too heavy as it will sometimes crack a flange, but in boiler nozzles it makes no difference.

Columbus, Ohio. L. A. Cowles.

Blowing Down Boilers

In reading Mr. Molloy's description of his practice in blowing down boilers, page 657 of the Apr. 29 issue, it was not clear to me why he blows down. The reason I blow down is to get rid of some of the dirty water or of the dirt in the water.

In order to do this I blow down when the fires are active, whether the pressure is high or low, but preferably low. When the fires are active the dirt in the boilers is mixed with the water; when the fires are dead the impurities settle out of the water and will be found on the tubes, the bottom of the boiler and on any projecting parts. When the fires are active the impurities are mixed with the water; when the fires are dead only a small amount of mud lying close to the blowoff will be removed. R. McLaren.

Toronto, Ont., Canada

Water-Column Blowoff Valves

On page 27, of the July 1 issue, R. A. Cultra favors gate valves as being better than globe valves for water-column blowoff connections. If the bottom connecting pipe fills with scale, the plug in the cross fitting below the column can be removed and a rod run through the pipe to clear it when a gate valve is used; it cannot be done with a globe valve in the piping.

If pipe of the proper size is connected to the water-columns, say 1 or 1¼ in., there is little chance of even a globe valve closing up. The top connection never closes, and the bottom valve seldom except where gross carelessness exists. The clogging usually occurs in the bottom connecting pipe where it passes through the hot space between the boiler front and the boiler. The only scale or sediment passing through the valve is what settles in the bottom pipe. On connecting globe valves it is good policy to place them sidewise instead of upright on horizontal pipes. This will eliminate the trap.

JAMES E. NOBLE.

Kingston, Ont., Canada.

Regarding the comments on water-column blowoff valves by R. A. Cultra on page 27 of the July 1 issue, I can agree with him in some things, but think that he has placed too much stress on some of the points that he has brought out in his communication. It is true that mud, etc., will collect in the pocket formed below the seat of a globe valve, and there is danger of the valve plugging up unless it is blown out at intervals, this of course depending on the character of the boiler water. However, blowing down a water column is an excellent practice to cultivate, regardless of whether the boiler is using muddy and scale-forming water or not.

Mr. Cultra's argument concerning the placing of globe valves is one that has been up for years, and engineers have their opinion regarding the proper way of placing them in a pipe line. Regarding the pressure on the valve bonnet, it seems to me that if a valve is so frail that it will not withstand the pressure continuously, such as would be exerted against the bonnet with a pressure coming above the disk, it would be a good idea to get a valve of more sturdy construction.

If Mr. Cultra's article is to be taken seriously, then globe valves should not be applied to any line under pressure, whether the pressure comes on top or below the disk, because according to his statement the only time the valve would be safe would be when it was closed and the pressure against the valve bonnet would be exerted only against such area of the valve disk as was exposed to the pressure in the pipe. However, when a globe valve is open, as most of them are at some time or other, the bonnet is under the pressure of the pipe, and if it can withstand this pressure at one time it should be capable of withstanding it at another. As a matter of fact, many globe valves in steam lines are open most of the time; therefore the pressure is continually exerted against the valve bonnet.

As to packing the valve stem, I have yet failed to find a globe valve that I could not pack while under steam pressure, regardless of whether the steam was on top or below the valve disk. Of course, if the steam is leaking out past the valve stem, it is not as easy a job as it would be if there were no steam.

It is not apparent that the instance Mr. Cultra brings out regarding a globe valve so connected that the pressure came on top of the disk and an attendant using a wrench on the wheel to screw it up so tight that the bonnet was forced off is a good argument. The fault was not with the valve; it was a case of bull-headed ignorance, and the bonnet could have been forced off just as well whether the pressure was exerted under the valve disk or on top of it. It is a wonder to me that he did not force the valve seat away from the valve body as well as the bonnet out of the valve.

According to my experience, I think Mr. Pascoe gave a very good reason for placing his valve so that the pressure came on top of the disk, and it is my belief that such an arrangement with the blowoff valve attached to a water-column pipe or water-glass connection is not at all dangerous.

E. A. JACKSON.

Baltimore, Md.

Remedy for Present Valve Setting

The accompanying indicator diagrams were taken from an 18 x 30-in. Corliss engine, double-eccentric, long-range cutoff, making 130 r.p.m. The diagrams shown in Fig. 1 were taken from the engine as I found it; diagrams Fig. 2 were taken after I had adjusted the valves the best I could. The valve chambers were bored out and new valves put in about eighteen months ago. The engine has been very wasteful of steam, and I was called in to see what I could do. I have made a saving in coal of about one ton per day of ten hours, but the engine pounds badly on the head end.

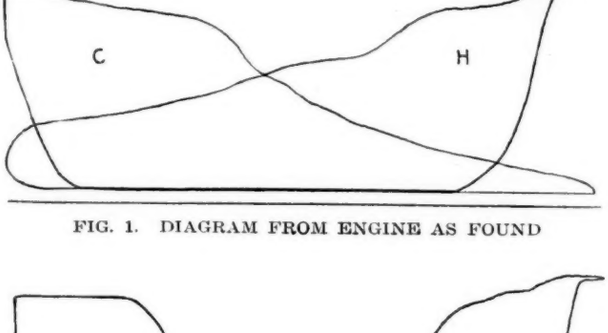


FIG. 1. DIAGRAM FROM ENGINE AS FOUND

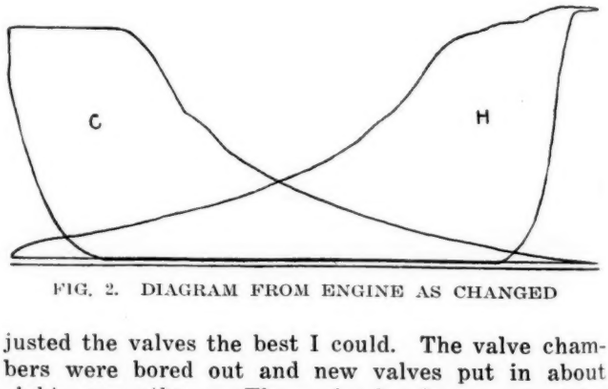


FIG. 2. DIAGRAM FROM ENGINE AS CHANGED

With a double-eccentric engine I understand that the steam valves should be open $\frac{9}{32}$ in. with the wristplate in the center. I found the head-end valve open $\frac{3}{8}$ in., and it is now open $\frac{5}{16}$ in. I cannot do any better, as the threads run out of the link head. The head-end steam valve is the only one I changed. There is no lead on this valve, and yet it is open with the engine on the center more than it should be. I would appreciate the advice of experts in double-eccentric engines. What should be done to get proper valve setting?

S. L. GILLIAM.

Madison Heights, Va.

Inquiries of General Interest

Disadvantage of Excessive Clearance—In a reciprocating engine operating with cutoff, if the exhaust is compressed to the initial pressure what effect has excessive clearance on the economy? S. J. R.

Excessive clearance is disadvantageous, as the high compression must be compensated by later cutoff, and consequently there must be a higher terminal pressure and less work of expansion out of the steam used by the engine.

Testing Safety Valves With Water Pressure—Cannot safety valves be tested satisfactorily with water pressure? E. M.

Steam or air safety valves should be tested with steam or air pressure, and water-pressure relief valves should be tested with water pressure; otherwise, in discharging, the valve is subjected to a different counterpressure than when relieving pressure under the conditions for which it is intended.

Theory of Injector—What is the theory of the action of an injector? R. B.

The steam passing from the high pressure in the boiler to the low pressure in the injector chamber expands suddenly so that a portion of its heat energy is converted into energy of motion. When condensed by contact with the water, it gives up some of its heat to the water, but retains enough of its kinetic energy to carry the water along with it against the pressure of the boiler.

Disposition of Heat in Gasoline Engines—In internal-combustion engines that use gasoline, what proportions of heat of the combustion are utilized in the generation of power, absorbed by cooling, and expelled in the exhaust? R. G. B.

The proportions vary with the type, design and load of the engine. Ordinarily, there is about 25 per cent. of the heat utilized in development of power, about 30 per cent. absorbed by jacket cooling water, about 40 per cent. discharged in the exhaust direct to the atmosphere, and about 5 per cent. of the heat lost by radiation.

Use of Brass for Pump Pistons—For handling hot water, why are pump-plunger pistons made of brass, and what is the advantage of brass piston parts for cold water pumps? P. K. D.

Hot water has a rapid corrosive action on cast iron and steel, and soft packing can be held tight for a longer time when the parts are made of brass. For pump pistons packed with soft packing, brass followers have the advantage over followers made of cast iron, as the latter sometimes break from swelling of the packing or from being set up too tight. When the follower rings are made of brass, they are only forced out of shape and usually can be restored to proper form by pressure or hammering.

Why Steam Valves of Duplex Pumps Have No Lead—Why is not lead given to the steam valve of a direct-acting duplex pump? C. W. M.

The pump must be capable of starting at any point of the stroke, and therefore the valve gear must provide for the steam to follow full stroke. With lead, steam would be admitted simultaneously on opposite sides of the piston, which could not then be started in either direction. The only purpose of lead in operation of the pump would be to stop the motion of the piston at the end of the stroke, and this is provided for by having each piston cover the exhaust passage near the end of the cylinder before completion of the stroke and thereby obtain a cushioning effect by compression of the exhaust thus entrapped in the space between the piston and the cylinder head.

Laminations in Boiler Plates—What is lamination of a boiler plate, why is lamination a source of danger, and how is the condition detected? W. F.

A lamination consists in separation of the material of the plate into layers that are not welded together, therefore lacking the strength and solidity of a perfect plate. With modern material the defect is rare, but in older practice, when wrought iron was the material employed for boiler plates, such defects were quite frequently met with, due to the presence of slag in the iron, which in the operation of rolling the plates would become thinned out into sheets separating layers of the iron and preventing them from becoming welded into a homogeneous plate. With continual changes of temperature and consequent expansions and contractions, it frequently happens that the laminations become separated and the thinner portion of the structure becomes raised, forming a blister. The chief danger from such a blister on the heating surface arises from the nonconductivity of heat and the danger of the plate becoming burnt or ruptured from becoming overheated. In examining a plate for laminations that are not apparent from the appearance of blisters, the hammer test is usually considered the most reliable. The plate is tapped over its surface, and an experienced ear can usually detect the location and approximate extent of lamination.

Different Water Levels in Connected Heating Boilers—The low-pressure gravity-return steam-heating system of a large public building is supplied by two cast-iron sectional boilers that are about 16 ft. apart and are connected to the main steam and return lines. The boilers are in duplicate and set at the same level. In the operation of the heating system trouble is experienced in maintaining the same water level in each boiler. What is the cause, and how can the trouble be remedied? R. G. M.

The trouble undoubtedly arises from difference in loss of pressure in the return water for overcoming friction of flow, and would be caused to some extent by the least variation in size, length and roughness of the return connections. Similar difference in frictional resistance to flow is shown by the different rates at which the water levels would drop from a common level if the boilers were emptied under atmospheric pressure, with discharge taking place through apparently identical outlet connections. Variation in the residual pressure results in maintenance of a different hydraulic head of water in the boilers, above the common connection with the main return. The loss of pressure from friction increases as the square of the velocity, and the difference of water level of the boilers increases faster than the increase in rate of water presented by the main return. With ordinary sizes of steam connections, the steam pressure in the boilers would be substantially the same, even for considerable difference in rates of evaporation, and although commonly attributed to difference of steam pressure, trouble from that cause is rare. The remedy is to make the cross-sectional areas of water connections to both boilers so large that the return water will have a very low velocity through the connections, with little loss and smaller difference of residual pressure. This can be accomplished by supplying larger connections or additional return connections. Difference in water levels of connected boilers cannot be entirely eliminated. The safest method of operation would be to use the boilers disconnected from each other and for independent sections of the heating apparatus.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Pulverized Coal as a Fuel for Boilers*

By EDWARD R. WELLES and W. H. JACOBI

IN SPEAKING of the advantages and disadvantages of pulverized coal as a fuel, they may be stated as follows:

a If ground sufficiently fine the the entire combustible content of the coal can be burned, thereby effecting fuel economies hitherto not attainable even with the better grades of coals burned under favorable conditions.

b It permits the use of all grades of coal, including peat and lignite, with an approximately equal degree of thermal efficiency for the same service, and increases very materially the energy that can be derived from the world's supply of coal.

c It possesses very largely the facility of control and combustibility of oil and gas fuels, thereby placing coal on a parity with these fuels.

The limitations of pulverized coal are:

a The very high temperatures attending its efficient combustion (see table) and the unsteady mode of its deflagration, necessitating special furnace construction to secure reliable service and to realize the possible economies it affords, preclude its ready application to existing equipment.

b The operating cost and attention required to maintain the necessary apparatus for its use may more than offset the fuel economies that can be effected in small independent services.

c The presence of ash, which may not always be collected and held under control.

d The human element, which will not submit to the peculiarities of its nature.

APPROXIMATE COMBUSTION TEMPERATURES OF CARBON AND BITUMINOUS COAL AND THE RESULTING PERCENTAGES OF CO_2

Percentage of excess air	0	25	50	75	100	125
Combustion temperature, deg. F.:						
Carbon	4,000	3,450	3,000	2,625	2,350	....
Average bituminous coal	4,860	4,000	3,325	2,860	2,500	2,220
CO_2 per cent	20.8	16.5	13.8	11.8	10.2	....

For flexibility and nicety of operation gaseous fuels rank first, being followed respectively by liquid fuels (oils), powdered coal and solid (lump) fuels. On the basis of cost they assume exactly the reverse order. Economy depends on the nature of the service and local conditions.

Preparation of Pulverized Coal

The valuable feature of pulverized coal is that by reason of its divided state it can be brought *en masse* into intimate contact with the air necessary for its combustion, and in consequence, when injected into a suitably heated hearth it burns completely, deflagrating almost as readily as atomized oil.

Obviously, the first requisite is to render the fuel into as fine particles as is possible, so that when mixed with air the mixture shall assume the form of a homogeneous gas. This analogy is comparative only, for no matter how finely broken and thoroughly mixed with air the coal particles are, they retain their solid structure and are therefore subject to a very arduous process of combustion, which is responsible for the attendant high temperatures that result.

The standard established in cement-mill practice, generally adopted for all purposes, is that 85 per cent. of the powder shall pass through a 200-mesh screen, and 95 per cent. through a 100-mesh screen. Coal so ground weighs from 35 to 45 lb. per cu.ft. and 1 lb. of it can be carried in suspension through smooth piping in about 5 lb. of air moving at low velocities. Experience shows that under favorable conditions 100 per cent. 60-mesh powder can be burned satisfactorily. This coarse fuel necessarily requires a longer time for its complete combustion and it can be carried in suspension only at high velocities. Its use, therefore, would be permissible only in furnaces which provide a long path for the resulting flame. In short chambers operating at low velocities these large particles fall to the bottom of the chamber before being consumed and coke, the result being a loss of fuel.

Granulated coal ranging in size from one-fourth inch to powder has been used as fuel for boilers aboard ship, it being blown into specially constructed hearths. This method has given good results in forcing the generation of steam, but it is not strictly in the class of burning pulverized coal in suspension and does not possess the same range of possibilities.

Coarsely pulverized coal has the redeeming quality of damping the temperature of the furnace and may be resorted to for the purpose of cooling overheated hearths without chilling; nevertheless, pulverized coal larger than the 80-mesh grade should be avoided in ordinary operation for best results. A uniform mixture averaging 100 per cent. 150-mesh or finer should be employed, especially in the case of low-grade coals.

Pulverizing mills ordinarily produce powder of the cement-mill standard, and on the basis of fairly dry coal the average cost of pulverizing runs from 15 to 30c. per ton ground at the rate of 2½ to 1¼ tons per hour, respectively.

Furnace and Combustion Losses Decreased

With pulverized coal, furnace and combustion losses can be greatly decreased as compared to those incurred in burning lump coal over grates, by reason of its manner of burning, and it is to that condition alone that very acceptable fuel economies can be effected by its use. Instances are recorded showing that 10,500-B.t.u. coal fired as powder in a given boiler setting has evaporated a larger amount of water than 12,090-B.t.u. coal fire by hand.[1] Invariably, records of tests made in steam plants of various capacities using pulverized coal as fuel indicate boiler thermal efficiencies of 75 to 80 per cent. and over, which parallel the best efficiencies obtainable with modern stokers in large installations. The consensus of opinion is that with the better methods of firing pulverized coal the high efficiencies observed, both in the hearth and in the boiler, remain fairly constant throughout a wide range of quantities of fuel burned, whereas with stokers, which permit only a rigid design of combustion hearth, beginning with the higher efficiencies in large boiler installations the efficiencies drop as the installations become smaller. This is self-evident in part, since in stoker practice only the better coals can be used to advantage and a certain amount of fuel loss cannot be prevented, whereas by pulverizing, all grades of commercial coals are admitted to the same service with equal merits and fuel losses may be avoided. And since deflagration, and therefore the combustion space necessary, becomes a measure of the actual amount of combustible present in the coal, the hearth losses remain practically constant for all conditions encountered in actual service.

The conclusion to be derived is that, other things being equal, the competition between the use of pulverized-coal firing and stokers for large boiler plants will be a matter of flexibility of service, convenience in operating and maintenance cost; but in small plants fuel economy will be the deciding feature along with the other advantages, and pulverized coal will obtain the preference, not only on the basis of combined first and operating costs, but especially so after the greater convenience and flexibility demonstrated.

Proper Velocity for Fuel Mixture

The proper velocity for the fuel mixture as determined by its inflammability can be found only by trial, and the condition to be fulfilled is that the base of the flame shall approach the outlet as closely as possible. A lower velocity may result in backfiring within the feed tubes, which are of appreciable dimensions, and cause a more or less destructive explosion. A higher velocity carries the mixture too far into the hearth before combustion begins, and has the effect of coking and consolidating the particles, which drop

*Abstract of a paper presented at the Spring Meeting of the American Society of Mechanical Engineers.

[1] G. F. Gashe, *Railroad Gazette*, vol. 34.

to the bottom of the hearth in the form of relatively large globules, thereby causing faulty combustion and loss of fuel. Coking of the combustible charge is very perceptible in connection with discharge outlets of large diameter such as are used in cement kilns. The action in this case has been attributed to more rapid combustion on the surface of the combustible jet, which has the effect of baking the core within. This difficulty has been overcome by using outlets in the form of a slot of the required cross-section, thereby exposing more surface to the hot gases in the hearth.

Volume of Flame or Zone of Oxidation

The volume of the flame—that is, the zone of oxidation—in general, cannot be predetermined on account of the many uncontrollable variables, and especially because the virtual temperature of combustion cannot be ascertained by present means and the real time element of complete oxidation is not definitely known. Observation and analysis show that, under similar conditions, more inflammable fuels burn with a shorter flame than the less inflammable. In connection with pulverized coal the problem becomes more complex on account of the variable amount of excess air required for its combustion. The values for this excess hitherto suggested vary widely and are so conflicting as to preclude their use. Nevertheless, based on the average temperatures of combustion and the amount and temperature of the gases required, it is possible to arrive at a very satisfactory conclusion regarding the dimensions for the combustion and gas space.

Briefly, though in the combustion of pulverized coal there is a wide margin for regulation by judiciously applying the conditions herein indicated, nevertheless, until more complete experimental data are available, it is necessary to consider every element entering—from the nature of the coal to the performance of the boiler—and to disregard all precedent existing in the burning of lump coal in order to secure satisfactory results with the powdered fuel.

Although in general furnaces are more or less special structures and their character is determined by the service they perform, their design and type of construction depend chiefly on the nature of the fuels used in their operation.

The combustion of a fuel results in gases charged with the available useful heat developed during their formation, and ash, in the case of fuels containing solid impurities. The quantity of gases and their temperature depend on the quality of the fuel and the amount of air used for combustion and dilution purposes, which can be varied to suit practical requirements.

In steam-boiler settings the duty of both boiler and furnace is a calorific one—that is, one of straight heating—and is measured by the amount of water evaporated in the boiler by the combustion gases from one pound of fuel.

The amount of water that can be evaporated in any type of boiler by a given quantity of fuel depends on the quality of the steam desired and the ability of the boiler to absorb the heat charge of the gases supplied by the furnace necessary for the generation of the steam required. So that, briefly stated, the boiler is subordinate to the steam requirements and the furnace subordinate to the performance of the boiler; and just as the design of boiler is varied to satisfy the steam requirements, so must the furnace proportions and mode of burning coal vary to supply the necessary gases for the efficient operation of the boiler, and in so doing secure the greatest fuel economy.

The nature of fuels plays the all-important part in the efficiency and performance of furnaces, regardless of their calorific value. By pulverizing and proper treatment all grades of coals may be dealt with on the basis of their burnable content, thereby rendering their use equally applicable to all heating services.

Design of Pulverized-Fuel Furnaces for a 500-Hp. Boiler

To demonstrate the possibilities of pulverized fuel along the lines indicated, a furnace for burning efficiently all grades of coal from the average best bituminous and anthracite qualities to lignite, and of such size as would be applied to a water-tube boiler of about 500-hp. capacity, has been designed, particles being given in the following paragraphs.

In working out this design for a boiler with a steam pressure of 175 lb., and working at 100 per cent. and 200 per cent. rating, consideration has been given to the best features of furnaces successfully burning pulverized coal and fuel oil. The temperatures of the gases delivered to the boiler have been assumed to be 1800 deg. F. and 2750 deg. F., respectively, for the two ratings, the boiler efficiency being taken at approximately 80 per cent. in both cases.

The purpose of this design is to study the possibilities of meeting as severe demands as are made at the boiler ratings selected, using all grades of powdered fuel.

The distinctive features of this furnace are the delivery of the fuel mixture and of the dilution air to insure perfect combustion, to permit regulation of the fire, and to guard against the slagging and destructive difficulties heretofore encountered. The air is supplied by suitable blowers and is heated before use by the waste flue gases for fuel mixing and by the body of the furnace for dilution purposes.

Regulation is accomplished by control of the fuel and of the air, the fuel-mixture spout outlets being proportioned to deliver, at maximum duty, a mixture containing 75 per cent. of the air required for perfect combustion.

Purpose of the Air Jets

The purpose of the air jets under the flame is to blow toward the ashpit the ash particles that may fall from the flame as well as the partly consumed particles of fuel. The latter are brought into the deflagration zone with a fresh supply of air and given a new chance to burn completely.

Rows of air jets on top of the flame are for the purpose of directing the flame over a longer path and providing thereby longer time for the complete oxidation of the fuel particles, protecting the furnace from the hottest portion of the flame and for aiding in the precipitation of ash toward the ashpit. Aside from supplying additional combustion and dilution air, the joint effect of the two rows of air jets is to carry the flame in suspension away from the furnace walls and the ash deposit, and fulfill thereby one of the principal requirements for the burning of pulverized coal.

The Ash Must Be Blown Off Occasionally

The idea of precipitating the ash by rapidly expanding the flame into a large space is applied, but it is not expected that all the ash can be thus collected. Some of the ash dust will be carried by the gases and deposited on the boiler tubes and surfaces beyond the hearth and must be blown off occasionally by soot blowers to a collecting hopper in the rear chamber of the boiler setting, from which it is discharged in a manner similar to that employed in removing the ash from the furnace.

The furnace design, though possessing good features, is not necessarily typical. In an actual case the conditions of the service would influence largely the most suitable arrangement.

Furnaces for burning pulverized fuel demand careful consideration, not so much on account of the novelty of the fuel, but because, like other fuels, it possesses its peculiarities, which do not obey a general rule and which must be carefully considered to secure the maximum of usefulness for each kind and size of service.

No comprehensive surveys for hydro-electric development have been made in the Philippines, and at present there are few water-power plants, though several are under consideration, notably one for the Manila Electric Railway and Light Co. Much interest is being shown in the subject owing to the rise in the price of coal from $4 per ton in 1914 to $30 in 1919. The rainfall in many places is ample, but the main difficulty is with adequate storage facilities. There is, however, a place in Mindanao where 250,000 hp. could be developed; the location is remote from populous centers, but near good iron ore.—*Commerce Reports.*

California 220,000-Volt 1100-Mile 1,500,000-Kw. Transmission Bus*

By R. W. Sorensen, H. H. Cox and G. E. Armstrong

California has available ample hydro-electric power to supply the industrial and agricultural demand for many years. Small developments aggregating 325,000 kw. have been completed, and many others of this type are available. There are also four large projects as given in Table I, which can readily be developed to a capacity of 1,500,000 kw. in the near future. The data for the following tables of resources and loads, of the northern part of the state, are taken from various reports that have been published, and no attempt has been made to verify them.

TABLE I. LARGE POWER RESOURCES

	Now Developed and Under Construction, Kilowatts	Proposed Developments, 1926, Kilowatts	Reasonable Future Development (Not Ultimate Capacity), Kilowatts
Pitt River	None	200,000	500,000
Feather River	100,000	200,000	300,000
Big Creek	100,000	300,000	500,000
Colorado River	None	None	200,000
Total	200,000	700,000	1,500,000

Total 1926 hydro-electric power development including small projects is 1,025,000 kw.

The best available information indicates a demand in 1926 approximately as shown in Table II.

TABLE II. DEMANDS FOR POWER ALONG PROPOSED DEVELOPMENT

	Kilowatts
1. Sacramento Valley, northern portion	70,000
2. Truckee River electrification	40,000
3. Sacramento Valley, southern portion	125,000
4. San Francisco Bay District	250,000
5. Fresno District	90,000
6. Bakersfield District, including Tehachapi electrification	125,000
7. Los Angeles District	300,000
8. Barstow and Needles District, including railroad electrification	40,000
Making a total of	1,040,000

In order to carry this load, approximately 500,000 kw. additional in hydro-electric capacity will be required. A demand such as shown in Table II can be supplied most economically by power developed in large units. Large power units require transmission lines of the highest possible economic voltage.

It has been shown that, for long transmission, 220,000 volts is economical under conditions that require a much more expensive construction than has proved adequate for the 150,000-volt lines of the Southern California Edison Co.[1] On this basis a plan as shown on the map is proposed. In this plan the interconnection of all the California power companies has been assumed, as an economic necessity for its best utilization. Interconnections of limited capacity are not entirely satisfactory because they fail just at the time they are needed most to transfer from one system to another large blocks of power.

The plan of the proposed scheme involves the construction of a two-circuit transmission system extending from Pitt River to Los Angeles, a distance of 570 miles. Branch lines of like voltage connect the three other power projects and the San Francisco load center to this main line on which the other load centers are located. The main line thus becomes a high-tension bus extending nearly the entire length of the state; hence its name, California Transmission Bus. This arrangement makes possible unlimited interconnection and exchange between all the power companies of the state.

Substations have been located at Marysville, Stockton, San Francisco, Fresno, Bakersfield and Los Angeles. These points are natural load centers and suitable points for connecting with the present power systems. On the Colorado River branch, the construction of which is dependent upon the electrification of the transcontinental railroads, substations would probably be located at Barstow and Needles.

*Abstract from a paper presented at the American Institute of Electrical Engineers Pacific Coast Convention, held in Los Angeles, Calif., September, 1919.

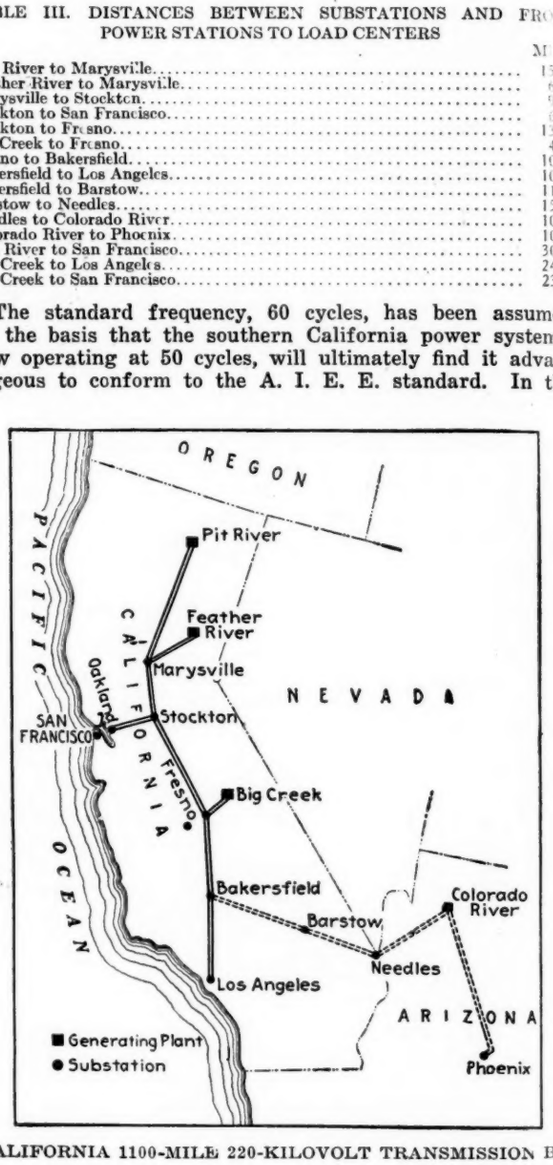
[1]Silver, Problems of 220-Kv. Power Transmission, A. I. E. E. Proceedings, June, 1919.

The substations divide the lines into sections of suitable length for practical operation, the longest section being 150 miles, as shown in Table III.

TABLE III. DISTANCES BETWEEN SUBSTATIONS AND FROM POWER STATIONS TO LOAD CENTERS

	Miles
Pitt River to Marysville	150
Feather River to Marysville	60
Marysville to Stockton	90
Stockton to San Francisco	60
Stockton to Fresno	130
Big Creek to Fresno	40
Fresno to Bakersfield	100
Bakersfield to Los Angeles	100
Bakersfield to Barstow	110
Barstow to Needles	150
Needles to Colorado River	100
Colorado River to Phoenix	100
Pitt River to San Francisco	300
Big Creek to Los Angeles	240
Big Creek to San Francisco	230

The standard frequency, 60 cycles, has been assumed on the basis that the southern California power systems, now operating at 50 cycles, will ultimately find it advantageous to conform to the A. I. E. E. standard. In the natural growth of the load shown in Table II, 70 per cent. of the 1926 load will be supplied by the 60-cycle systems. Interconnection of such large load centers or power sources through frequency changers, limits the exchange of power, is uneconomical, and increases tremendously the required operating vigilance.



CALIFORNIA 1100-MILE 220-KILOVOLT TRANSMISSION BUS

The practicability of the high-voltage line has been well demonstrated by over five years of remarkably successful operation of the 150,000-volt lines of the Southern California Edison Co., which, during this period, have delivered from the Big Creek power houses over the 240-mile lines to the Los Angeles distribution system, 1,200,000,000 kw.-hr. at an average efficiency of 87.5 per cent. with a 45 per cent. load factor. During this period there have been no interruptions for which the high voltage is responsible, and on the contrary the system has been free from disturbance and interruption to a greater degree than the lower-voltage lines in the same locality.

The present Big Creek lines can be operated at 220,000 volts 60 cycles without material change, and this is proposed as a link of the transmission bus, and its operation under these conditions will be analyzed and applied to conditions of the proposed system.

International Trade Conference at Atlantic City

An international Trade Conference will be held at Atlantic City Sept. 30 to Oct. 3, by invitation of the Chamber of Commerce of the United States. An exceptional program has been arranged. Under the heading of Major Topics is scheduled economic readjustment of commercial and industrial conditions in England, France, Italy and Belgium. Finance will be another general subject. It includes foreign exchange and all the forms in which questions of credits may arise. Under this subject there will be discussion of the various plans for extending credits which have been proposed in the United States.

Fair play in international commercial competition will likewise be promoted. Questions of food and of the cost of living will have a prominent place on the program, according to the plans that have been made in advance.

There will be an American committee for every subject, including producers, shippers and economists who will meet from day to day with the foreign delegates, who have been making careful preparations for the conference and will come fully equipped to give the American public the information needed on all the subjects outlined.

Alone, experience will not carry a man to his ultimate goal in power-plant work—it requires ingenuity, loyalty, study, sympathy and a vision of greater service to round out his real value. These characteristics should not be overlooked in measuring a man's ability. All too frequently, because of their inherent invisibility and peculiarly personal nature, these factors are not listed on the credit side of the ledger, and Old Man Experience cultivates an exaggerated idea of his importance.—*Refrigerating World.*

A noted English jurist says: "The longer I live the more certain I am that the great difference between me, between people and the powerful, is energy—invincible determination—a purpose once fixed and then death or victory. That quality will do anything that can be done in the world; no talent, no circumstances, no opportunities, will make a man a two-legged creature without it."—*The Monad.*

A steady increase in the American exports to Australia is noticeable since 1913, in which year machinery and metal manufactures amounting to $14,654,183 were sent to the island continent. In 1914-15, $15,283,903; in 1915-16, $16,046,055; in 1916-17, $18,435,108; and in 1917-18, $19,066,503. —*Commerce Reports.*

New Publications

EXERCISES IN LETTERING. By George G. Greene. Published by the Bruce Publishing Co., Milwaukee, Wis., 1919. Paper, 2¾ x 5¼; 32 pages.

These little books are vest pocket editions of the slant gothic and the vertical gothic styles of lettering and are especially adapted to the use of the mechanical draftsman. The construction of the letters is explained and illustrated. A separate complete alphabet with the figures is inclosed with each volume and may be pinned to the drawing board for reference.

COLLOIDAL FUELS

"Colloidal Fuels" is the title of a 28-page bulletin recently published by Lindon W. Bates, 141 Broadway, New York City. It embodies matter and studies not heretofore published, particularly the demonstration as to the relative efficiencies and advantages of liquid versus solid fuel. The relation of colloidal fuels to coal, to the production of power and heat and to fire prevention and insurance is well presented.

Personals

Frank B. Fairbanks is now advertising manager of the Duff Manufacturing Co., Pittsburgh, Penn.

F. C. Pratt, who has been assistant to the vice president of the General Electric Co., was recently elected vice president.

Col. E. H. Abadie has been appointed comptroller of the division of operations of the United States Shipping Board in place of John J. Nevin, resigned.

F. A. Moreland, resigned his position as treasurer of the Vulcan Fuel Economy Co., Chicago, Sept. 1, having been connected with the company since early in 1910.

John Kelly, who for a number of years was New York district manager of the Edison Storage Battery Co., has been appointed general sales manager of the company, with headquarters at Orange, N. J.

C. H. Johnson, who has been chief engineer in charge of power stations of the Columbus (Ohio) Railway, Power and Light Co. for the last two years, has resigned to take a position with the Combustion Engineering Co., New York City.

F. H. Van Gorder has been appointed manager of the Western Electric Co.'s Newark (N. J.) store. He has been connected with the company since 1907, successively as salesman with the Chicago house, the Detroit store, and as power apparatus specialist at the New York office.

A. M. Dudley, who has been engineer-in-charge of alternating-current motor design of the Westinghouse Electric and Manufacturing Co. for a number of years, has been promoted to the position of engineer-in-charge of automotive equipment design of the company.

R. H. Ballard, president of the National Electric Light Association, left Los Angeles Sept. 12 on a second Eastern trip in the interests of the organization. He will attend a meeting of the Public Policy Committee which has been called by Chairman John A. Britton, to be held at Association headquarters in New York on Oct. 1. Taking advantage of President Ballard's presence in the East, a general meeting of the membership committee has been called by Chairman Walter Neumuller, of New York, and of the Company Sections Committee by Chairman Frank A. Birch, of Philadelphia. Both of these meetings will be held in New York. Mr. Ballard will stop in St. Louis on Sept. 15 for a discussion of association affairs in that section of the country with company executives residing in that region. He will address the convention of the Southeastern Section, which will be held at Asheville, N. C., Sept. 17-19, on the morning of Sept. 18. He will return to New York on Sept. 24, after attending the New England Section Convention, and will be at headquarters for the following two weeks, returning to the Pacific Coast in October, after scheduled stops at Detroit, Chicago, Minneapolis, Butte, Seattle, Portland and San Francisco.

Engineering Affairs

The National Association of Stationary Engineers, at the recent annual convention, voted to authorize the national president to confer with the Canadian Association of Stationary Engineers looking toward closer relations between that body and the N. A. S. E., the committee to report to the next national convention. The newly elected officers of the ladies' national auxiliary for the next year are: President, Anna C. Artkamper, Chicago, Ill.; vice-president, Mary E. Lamb, Pittsburgh, Penn.; secretary, Lenore W. Farmer, Columbus, Ohio; treasurer, Mary T. Mahon, Chicago, Ill.; chaplain, Anna Morris, Wilmington Del.; doorkeeper, Catharine Bastian, Chicago, Ill.; conductor, Sophie Legner, Cincinnati, Ohio. Gertrude P. Hunt, chairman pension fund soliciting committee, and Sadie Armer, chairman pension fund booster committee.

Miscellaneous News

Tennessee River Power Plants—Extensive plans are being made for the erection of a series of power plants on the Tennessee River. The plans propose the erection of six or more dams between Knoxville and Chattanooga. The entire enterprise, it is predicted, will cost between $16,000,000 and $20,000,000.

The New England Water Works will hold its thirty-eighth annual convention in Albany, N. Y., Sept. 30-Oct. 3, with headquarters at the Hotel Ten Eyck. Among the various papers to be presented the following are of interest to *Power* readers: "Pumping Engines for Small Water Works Plants," by Creed W. Fulton; "Tests of the Uniflow Pumping Engine," by D. A. Decrow.

The New Million Dollar Laboratories of the Bureau of Mines, Department of the Interior, Pittsburgh, Penn., will be dedicated Sept. 29-Oct. 1. The ceremonies promise to bring to Pittsburgh for the three days the most prominent mechanical engineers and mining and metallurgical men of the nation. The Bureau of Mines, in co-operation with the Pittsburgh Chamber of Commerce, has already completed an elaborate program of events, which includes the presence of high and state government officials besides the leading men of scientific and mining thought in the country. Dr. Van H. Manning, Director of the Bureau, will preside at the dedicatory ceremonies.

Business Items

E. B. Badger & Sons Co., Boston, Mass., has opened an office in Chicago, with Harry E Wheeler in charge.

The Ashton Valve Co., Boston, Mass., announces that Willson & Morison, 408 Rialto Building, have been appointed as the company's exclusive agents for that territory.

The Western Electric Co. has recently opened a new branch sales office and warehouse, at 334 East Bay St., Jacksonville, Fla., in charge of A. H. Ashford.

The Williamsport Wire Rope Co., Williamsport, Penn., has opened a branch office and warehouse in Chicago, the office at 122 South Michigan Ave., and the warehouse at 755 West Quincy St., under the direction of C. M. Ballard, formerly connected with the company's Cleveland branch office.

Trade Catalogs

The Culm Burn Grate Co., Philadelphia, Penn., has issued a bulletin describing the "Culm Burn Grate," which shows how coal dirt may be made 98.81 per cent. efficient.

The De Laval Separator Co., New York City, has recently issued bulletins Nos. 100, 101, 102 and 103, all having reference to the De Laval method of oil purification. Bulletin No. 100 devotes 23 pages to lubricating oils, cutting oils, hardening oils and fuel oils. Bulletin 101 devotes 16 pages to a manual for reclaiming, cutting and hardening oils. Bulletin 102 devotes 20 pages to the De Laval method of reclaiming crank-case oils. Bulletin No. 103 has 12 pages describing the De Laval method of purifying and reclaiming oils. All four bulletins are well illustrated and contain much useful information.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.40@2.85	$2.90@3.35
F. o. b. Philadelphia, gross tons	4.55@5.05	5.10@5.60
F. o. b. New York, gross tons	4.90@5.40	5.45@6.05
Alongside Boston (water coal), gross tons	6.65@7.15	7.20@7.75

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are quoted at $6.00 @6.50 per gross ton f. o. b. Norfolk and Newport News, Va., in response to export demand. There continue practically no sales for coastwise shipment. On cars Providence these grades are quoted at $9.00 @9.25.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.30	$7.05
Egg	6.35	8.20	Buckwheat	3.40	5.15
Stove	6.60	8.45	Rice	2.75	4.50
Chestnut	6.70	8.55	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.70@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@2.90
Reynoldsville	2.85@2.90
Quemahoning	3.25@3.50
Somerset (medium)	3.00@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.65@2.75
Fairmont	2.50@2.65
Fairmont ¾ in.	3.10@3.25
Latrobe	2.75@2.90
Greensburg	2.75@3.00
Westmoreland ¾ in.	3.50@3.75
Westmoreland run-of-mine	3.20@3.35

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Anthracite Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.35	8.20	Rice	2.75	3.65
Stove	6.60	8.45	Boiler	2.50	3.50
Nut	6.70	8.55	Barley	2.25	3.15
Pea	5.30	6.90			

PITTSBURGH—Counting out occasional low and high priced sales involving but small tonnage, the great bulk of the transactions is quotable as follows, Pittsburgh District:

Steam:	Per Net Ton
Slack	$2.10@2.30
Mine-run	2.50@2.60
Gas:	
Slack	2.20@2.40
Mine-run	2.50@2.70
Prepared sizes	2.60@2.90

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.30@2.60	$2.30@2.60	$2.40
Black Creek and Cahaba	3.45@3.85	3.45@3.85	3.05
Jagger - Pratt Corona	2.85	3.00	2.45
Blacksmith	....	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	5.00@5.50
Corona	3.50
Jagger	3.50
Montvallo	5.50@6.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$3.25	$2.75@3.00	$2.75
Mine run	2.40*@2.60	2.25@2.40	2.00@2.20
Screenings	2.10*@2.30	1.75@2.00	2.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1.07½; other rates $0.92½.

New Construction

PROPOSED WORK

Mass., Amherst—James H. Ritchie, Arch., 8 Beacon St., Boston, will receive bids for the construction of a 3 story, 60 x 155 ft. dormitory and dining room, for the Massachusetts Agricultural College, here. A hot water heating system will be installed in same. Total estimated cost, $150,000.

Mass., Belchertown—The Massachusetts Committee on Mental Diseases will receive bids September 29 for the construction of a 2 story, 64 x 89 ft. dormitory and a 3 story, 88 x 103 ft. power house, on State Grounds, for the Massachusetts Hospital, here. Two tub boilers and two engines will be installed in same. Kendall & Taylor Co., 93 Federal St., Boston, Arch.

Mass., Thorndike—Leary & Walker, Engr., New Bedford, will soon award the contract for the erection of a 6 story, 75 x 163 ft. factory here, for the Thorndike Co. A steam heating system and electric power will be installed in same. Total estimated cost, $175,000.

Conn., East Norwalk—Crofut & Knaff, Water St., South Norwalk, retained Fletcher-Thompson, Inc., Engr., 1089 Broad St., Bridgeport, to prepare plans for a 5 story, 60 x 300 ft. and 3 story 210 x 300 ft. factory and a 1 story, 60 x 150 ft. power plant, on Van Zandt Ave. Total estimated cost, $500,000.

Conn., New Haven—J. A. Wetmore, Supervising Architect, Treasury Department, Washington, D. C., received bids for installing motor driven triplex pumps in the Post Office here, from John R. Proctor, 74 Courtland St., New York City, $1465; John D. Kelly, 93 Meadow St., New Haven, $1861; E. S. Downs Co., 756 Broad St., Newark, N. J., $2414.

N. Y., Brooklyn—Kahan & Feldman, 25 Madison Ave., New York City, had plans prepared for the construction of a 5 story, 80 x 295 ft. factory, on Suydam St. between Wyckoff St. and Irving Ave. A steam heating system will be installed in same. Buchman & Kahn, 56 West 45th St., New York City, Engr. and Arch.

N. Y., Kings Park—The State Hospital Commission, Capitol, Albany, received bids for installing heating system in the proposed hospital for Acute Patients at Kings Park State Hospital, here, from A. B. Barr & Co., 6 River St., Yonkers, $21,800; Adams Britz & Co., Inc., 1769 Park Ave., New York City, $21,900; E. Rutzler Co., 404 East 49th St., New York City, $22,327. Noted Sept. 2.

N. Y., Lockport—Paul A. Davis, Arch., 1713 Samson St., Philadelphia, Pa., will soon receive bids for the construction of a 1 story 50 x 60 ft. bank building, for the National Exchange Bank, 45 Main St. A steam heating system will be installed in same.

N. Y., Marcy—The State Hospital Commission, Capitol, Albany, will receive bids until Oct. 7, for the construction of a 1 story, 65 x 280 ft. heating building and a 1 story, 80 x 120 ft. boiler room at the Utica State Hospital here. Equipment includes three 500 h.p. boilers, two fan blowers, one 125 kw., one 75 kw. generators, pumps, motors, etc. Total estimated cost, $500,000.

N. Y., New York—The Board of Education, 500 Park Ave., is having plans prepared for the construction of a 4 story, 92 x 194 ft. school on Bathgate Ave. and 182nd St. A steam heating system will be installed in same. Total estimated cost $120,000. C. B. J. Snyder, Municipal Bldg., Engr.

N. Y., New York—The Eagle Pencil Co., 703 East 13th St., will soon award the contract for the construction of a 6 story, 75 x 200 ft. factory on Avenue D. between 13th and 14th Sts. A steam heating system will be installed in same. Buchanan & Kahn, 56 West 45th St., Engr. and Arch.

N. Y., New York—M. Hausle, Arch., 3307 3rd. Ave., Bronx Boro., is preparing plans for the construction of a 2 story asphalt plant. A steam heating system will be installed in same. Total estimated cost, $100,000. Owner's name withheld.

N. Y., New York—M. Hausle, Engr., 3307 3rd. Ave., Bronx Boro., is in the market for heaters, conveyors, motors, boilers and elevators to be installed in a proposed plant. Owners name withheld.

N. Y., New York—J. A. Wetmore, Supervising Architect, Treasury Department, Washington, D. C., rejected bids for the construction of the temporary boiler plant in the U. S. Marine Hospital, here.

Pa., Philadelphia—The American Preserve Co., 946 Beach St., is having plans prepared for the construction of a 5 story, 80 x 250 ft. factory, and a 1 story, 50 x 70 ft. boiler house, on 3rd and Lehigh St. A steam heating and vacuum system will be installed in same. Peuchert & Wunder, 310 Chestnut St., Arch. and Engr.

Pa., Philadelphia—The Marcus Felt Realty Co., 1303 Market St., plans to construct a 20 story, 75 x 150 ft. store and office building on Market and 13th St. A steam heating system will be installed in same. Total estimated cost, $2,500,000. Graham, Anderson, Probst & White, Railway Exchange, Chicago, Arch.

Md., Baltimore—Israel Silberstein, 607 Equitable Bldg., plans to construct a 10 story, 140 x 181 ft. auto exchange building on St. Paul and Pleasant St. Sub bids will be taken on steam heating plant. Total estimated cost, $1,000,000. G. R. Callis, Jr., Melvin Ave., Catonsville, Arch.

N. C., Brevard—Transylvania County will receive bids until October 13 for the construction of a 3 story, jail and court house. Total estimated cost, $150,000. Heating and plumbing bids will be received separate from construction bids. T. E. Davis, Asheville, Arch.

S. C., Charleston—Spec. 4010—The Bureau of Yards and Docks, Navy Department, Washington, D. C., received bids for installing mechanical stokers in power plant here, from the Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Washington, D. C., $10,391; Sanford Riley Stoker Co., 25 Foster St., Worcester, Mass., $14,520; American Engineering Co., Aramingo and Cumberland St., Philadelphia, Pa., $15,450. Noted Sep. 2.

Ohio, Cleveland—J. N. Ackerman, Engineers Bldg., plans to construct a 1 story, 100 x 500 ft. moving picture studio on West 25th St. A steam heating system will be installed in same. Total estimated cost, $500,000.

Ohio, Cleveland—The Altamont Realty Co., Williamson Bldg., plans to construct a 6 story, 99 x 125 ft. office building at 1730 East 12th St. A steam heating system will be installed in same. Total estimated cost, $350,000.

Ohio, Ceveland—J. Babin, 13661 Euclid Ave., plans to construct a 5 story, 85 x 286 ft. commercial building on Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Cleveland Public Library Association, 1375 Euclid Ave., is receiving bids for the construction of an 8 story, 200 x 400 ft. public library on East 3rd St. and Superior Ave. A steam heating system will be installed in same. Total estimated cost, $3,000,000. Walker & Weeks, 1900 Euclid Ave., Arch.

Ohio, Cleveland—The Cleveland & Sandusky Brewing Co., American Trust Bldg., plans to construct a 2 story, 100 x 170 ft. bottling plant addition on East 55th St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Cleveland Railway Co., Leader News Bldg., is receiving bids for the construction of a 5 story, 49 x 80 ft. sub station at 13006 Woodland Ave. A steam heating system will be installed in same. Total estimated cost, $50,000. C. H. Clark, Engr.

Ohio, Cleveland—The Federal Packing Co., East 4th St., plans to construct a 4 story, 40 x 115 ft. cold storage plant. Estimated cost, $100,000. Architect not selected.

Ohio, Cleveland—The Greenlawn Realty Co., Society for Savings Bldg., plans to construct an 8 story, 100 x 200 ft. commercial building at 3208 Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

Ohio, Cleveland—G. W. Hale, Leader News Bldg., plans to construct a 6 story, 95 x 300 ft. commercial building on East 9th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—L. W. Kelley, Hickox Bldg., to construct a 10 story, 148 x 220 ft. commercial building at 2425 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—L. W. Kelley, Hickox Bldg plans to construct a 6 story, 80 x 200 ft. hotel on Euclid Ave. A steam heating sytem will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Kelly Springfield Tire Co., Prospect Ave., plans to construct a 5 story, 90 x 200 ft. sales building addition on East 46th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Lakeside Hospital Association, East 12th St. and Lakeside Ave., plans to construct a 12 story, 200 x 350 ft. hospital on University Circle. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Ohio, Cleveland—E. D. Latimer, 12037 Lake Ave., plans to construct a 7 story, 120 x 200 ft. commercial building on East 50th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $200,000.

Ohio, Cleveland—Frank C. Newcomer, Citizens Bldg., plans to construct a 6 story, 100 x 125 ft. commercial building on Euclid Ave. and 86th St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Paudett Investment Co., Citizens Bldg., plans to construct a 6 story, 94 x 122 ft. loft building at 1825 East 18th St. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The Petrequin Paper Co., West 3rd St., plans to construct a 4 story, 120 x 200 ft. commercial building at East 48th St. and prospect Ave. a steam heating system will be installed in same. Total estimated cost, $120,000.

Ohio, Clevland—The Prame Realty Co., Williamson Bldg., plans to construct an 8 story, 100 x 200 ft. commercial building on Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

Ohio, Cleveland—The Western Electric Co., 413 Huron Rd., plans to construct a 6 story, 100 x 100 ft. warehouse and office building on Carnegie Ave. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The White Motor Car Co., East 79th St., is having plans prepared for the construction of a 1 story, 200 x 600 ft. factory addition. A steam heating system will be installed in same. Total estimated cost, $600,000.

Ohio, Cleveland—The Zenith Tire & Rubber Co., Schofield Bldg., is having preliminary plans prepared for the construction of a 1 story factory on Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $10,000,000. A. W. Harris, Schofield Bldg., Arch.

Ohio, Cleveland Heights — (Warrensville P. O.) Israel & Makoff, 3533 Woodland Ave., plans to construct a 6 story 100 x 150 ft. theatre on Euclid Blvd. A steam heating system will be installed in same. Total estimated cost, $175,000.

Ohio, Urbana—The Urbana Packing Co. has awarded the contract for the construction of a 2 story, 30 x 75 and 30 x 60 ft. power house and storage plant, to J. A. Poss, Springfield. Estimated cost, $30,000.

Ind., Muncie—The Board of Commissioners, will receive bids October 11 for the erection and completion of power house and laundry, at the Delaware County Orphan's Home, here.

Mich., Adrian—Peter Dederick, Arch., 501 Chamber of Commerce, will soon award the contract for the construction of a 3 story, 69 x 136 ft. school, for St. Joseph's Academy. A steam heating system will be installed in same.

Mich., Bay City—The Board of Education is having plans prepared for the construction of a 3 story high school, on Columbus Ave. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Pratt, Bickel & Campbell, 814 Tower Ct., and Perkins, Fellows & Hamilton, 514 Crapo Block, Chicago, Ill., Arch.

Mich., Caro—The Caro Water Co. plans to construct a pumping plant and storage reservoir. Estimated cost, $25,000.

Mich., Detroit—The Garfield Cartage Co., Harper Ave., is having plans prepared by A. G. Schutt, Engr., 1333 Book Bldg., for the construction of a 1 story, 30 x 70 ft. garage. A steam boiler for heating purposes will be installed in same.

Mich., Detroit—The General Ice Delivery Co., Grand River Ave., is having plans prepared for the construction of a 1 story, 36 x 322 ft. ice storage plant on Warren Ave. An electric motor for power and an ice handling conveyor will be installed in same. Dalton R. Wells, 435 Woodward Ave., Arch.

Mich., Detroit — Albert Kahn, Arch., Marquette Bldg., is receiving bids for the construction of a 1 story, 275 x 528 ft. automobile factory, for the Paige Detroit Motor Car Co. McKinstry and Fort St. W. A steam heating system and electric motors for power will be installed in same.

Mich., Detroit—Albert Kahn, Arch., Marquette Bldg., is receiving bids for the construction of a 2 story, 60 x 100 ft. administration building on Wyoming and West Warren Ave., for the Detroit Seamless Steel Tube Co., 841 Jefferson Ave. W. A steam heating system will be installed in same. Total estimated cost, $70,000.

Mich., Detroit—J. Lawson Miller, Arch., 15 Goebel Bldg., is preparing plans for the construction of a 2 story, 43 x 100 ft. factory on Orleans St. and Milwaukee Ave. A steam heating boiler and electric motors for power will be installed in same. Total estimated cost, $35,000. Owner's name withheld.

Mich., Flint—Champion Ignition Co. will soon award the contract for the construction of a 3 story, 108 x 178 ft. factory, on Industrial Ave. and Harriet St. Steam heating equipment, boiler and accessories, mechanical conveyors, etc. will be installed in same.

Mich., Hamtramck—Raseman & Freier, Arch., 1302 Penobscot Bldg., Detroit, preparing plans for the construction of a 4 story, 100 x 200 ft. factory here. A steam heating plant will be installed in same. Total estimated cost, $200,000. Owner's name withheld.

Mich., Oakwood—The Board of Education plans to construct a school. A steam heating system will be installed in same. Total estimated cost, $230,000. Van Leyen, Schilling & Keough, Union Trust Bldg., Detroit, Arch.

Ill., Chicago—Balaban & Katz, 3535 West 12th St., are having preliminary plans prepared by C. W. and G. L. Lapp, Arch., 190 North State St., for the construction of a 2 story, 160 x 170 ft. theatre on State and Lake St. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

Ill., Chicago—The B. P. O. Elks, E. P. Rupert, Arch., 154 West Randolph St., is having palns prepared for the construction of a 4 story, 60 x 120 ft. club house on South Side. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ill., Chicago—G. C. Nimmons & Co., Arch., 122 South Michigan Ave., is receiving bids for the construction of a 5 story, 125 x 127 ft. addition to wall paper building, for the Sears Roebuck & Co., Harvard and Homan Ave. A steam heating system will be installed in same. Total estimated cost, $225,000.

Ill., Joliet—The Bnai Jacob Congregation is having plans prepared for the construction of a 1 story, 60 x 100 ft. synagogue on Lincoln St. A steam heating system will be installed in same. Total estimated cost, $100,000. D. S. Klafter, 64 West Randolph St., Chicago, Arch.

Wis., Elkhorn—The city will soon award the contract for excavating and laying 9610 ft. of 8-in. sewer, 1240 ft. of 4-in. cast iron pipe, etc., and is in the market for sewage pumping machinery and other equipment. Total estimated cost, $30,000. A. C. Olsen, City Hall, Engr.

Wis., Hartford—The city is having plans prepared by Cahill-Douglas, Engr., Gross Bldg., Milwaukee, for the construction of a 1 story, 60 x 110 ft. power plant. A steam heating system and electric power will be installed in same. Total estimated cost between $50,000 and $60,000.

Wis., Milwaukee—Vaughn & Meyer, Security Bldg., is interested in manufacturers of gas engine economizers.

Minn., Biwabik—L. R. Christensen, Secy., Bd. Education, will receive bids until September 30, for the construction of a 2 story, 100 x 100 ft. addition to high school on Main St. A steam heating system will be installed in same. Total estimated cost, $100,000. C. E. Nystrom, Palladio Bldg., Duluth, Engr. and Arch.

Minn., Duluth—The Duluth Show Case Co., 2800 West Superior St., plans to build a 3 story, 75 x 280 ft. factory, on 49th Ave. W. A steam heating system will be installed in same. Total estimated cost, $175,000 Anthony Puck, Forrey Bldg., Engr. and Arch.

Minn., Minneapolis—B. N. Schneider, 232 Plymouth Bldg., is receiving bids for the construction of a 6 story, 122 x 178 ft. hotel and business house, on Franklin and Colfax St. Vapor heating system and elevators will be installed in same. Total estimated cost, $800,000. Frederick Van Antwerp, 240 LaSalle Bldg., Engr. and Arch.

Kas., Garden Plain—The city plans to construct an electric light plant. Estimated cost, $15,000. E. Behn, cl. W. B. Rollins & Co., 209 Railway Exchange, Kansas City, Mo., Engr.

Kan., Wichita—The Sisters of Charity will receive bids October 1 for the construction of a 2 story 57 x 90 auditorium, a 3 story 36 x 144 ft. dormitory and a 2 story 37 x 90 ft. chapel. Steam heating systems will be installed in same. Total estimated cost, $250,000. White & Dean, 30 Bellefontaine St., Kansas City, Mo., Arch.

Neb., Omaha—John Latenser & Sons, 632 Bee Bldg., will soon award the contract for the construction of a 6 story, 106 x 120 ft. hospital on 26th St. and Dewey Ave., for the Lister Hospital, 14th St. and Capital Ave., to include a power plant, generators and ice machine, etc. Total estimated cost, $300,000.

N. D., Halton—The city voted $10,500 bonds to improve and enlarge electric light plant.

Mo., St. Louis—The Liberty System Corporation, 2310 Locust St, plans to construct a 2 story, 65 x 450 ft. factory. A steam heating system will be installed in same. Total estimated cost, $145,000. P. J. Brahshaw, 722 Chestnut St., Arch.

Okla., Hockerville—The Aztec Mining Co. has leased the property of the old Lucky Strike Mine, whose mill was recently destroyed by fire, and plans to build a hand-jig plant on same. The company is in the market for boiler, hoist and hand-jigs. Harry Larsh, Mgr.

Okla., Muskogee—The Board of Education is having plans prepared for the construction of a 3 story, 100 x 120 ft. high school. A steam heating system will be installed in same. Total estimated cost, $230,000. H. O. Valeur & Co., 705 Phoenix Bldg., Arch.

Okla., Tulsa—The Board of Education is having plans prepared by G. W. Winkler, Arch., 414 Palace Bldg., for the construction of a 3 story, 125 x 260 ft. high school. A steam heating system will be installed in same. Total estimated cost. $350,000. Hedrick & Huff, Kansas City, Mo., Engr.

Col., Flagler—The Town Council will receive bids until September 29, for the construction of a waterworks system and pumping plant and is in the market for one 100,000 gal. tank on tower, 100 ft. to balcony, 2 deep well pump heads, 50 gal. per minute capacity, one 35 hp. oil engine, one 75 hp. oil engine, suitable generators for above engines. Total estimated cost, $60,000. R. D. Salisbury, 1415 East Colfax Ave., Engr.

N. M., Lordsburg—The Bonney Consolidated Copper Co. plans to construct a new power plant. Semi Diesel or distillate engines, 400 hp. in 2 or 4 units, electrical geneators, triplex pump and compressors, etc. will be installed in same. Total estimated cost, $110,000. J. P. Portens, Supt.

Ore., Bend—The Bend Water, Light & Power Co. plans to construct a 1000 kw. steam plant to double present power output. Total estimated cost, $100,000. J. H. Foley, Bend, Mgr.

Ore., Portland—The Commission of Public Docks, foot of Stark St., will receive bids until September 25, for furnishing and delivering electrical equipment for charging storage battery trucks, at St. John's Terminal, Pier No. 1. Estimated cost $5000. G. B. Hegardt, c/o Public Docks Commission, Engr

Cal., Bakersfield—The Conklin-Brodek Estate, c/o Orville Clark, Arch., Bakersfield, is having plans prepared for the construction of a 3 story, 115 x 132 ft. store building, on 20th and Chester St. Cooling, heating and automatic sprinkler systems will be installed in same. Total estimated cost, $100,000.

Cal., Fillmore—The city plans election to vote on $20,000 bonds to construct an additional pumping plant, and extend distributing system.

Cal., Long Beach—The Board of Education received lowest bid for installing heating system in the proposed 2 story school on American Ave., from J. Hokom, 4312 Moneta Ave., Los Angeles, $12,248.

Cal., Long Beach—The Trident Packing Co., Long Beach, will take over the plant of the Pacific Packing Co. and plans to build a refrigeration plant and cold storage house addition to same. Total estimated cost, $50,000.

Cal., Los Angeles—The Board of Public Works will receive bids until October 6 for furnishing pumping equipment for the Manchester Avenue Sewage pumping plant. A. C. Hansen, City Engr.

Ont., Toronto—The William Davies Co., Ltd., 521 Front St., plans to construct a 3 story store and office building, on Front St. A steam heating system will be installed in same. Total estimated cost, $150,000. Hynes, Feldman & Watson, McKennon Bldg., Arch.

Ont., Windsor—The Board of Education, LaBelle Bldg., will receive bids about September 24, for the construction of a 3 story, 215 x 230 ft. school on Giles Blvd. A steam heating system consisting of boiler, pump, motor and fan will be installed in same. Total estimated cost, $200,000. A. H. McPhail, Board of Trade Bldg., Arch.

Sask, Melville—The Grand Trunk Pacific RR., McGill St., Montreal, plans to erect an electric power plant here. Total estimated cost, $110,000. H. R. Safford, Ch. Engr.

CONTRACTS AWARDED

Mass., Lowell—Massachusetts Cotton Mills, Canal St., has awarded the contract for the construction of a water power plant, to the H. P. Cummings Construction Co., 14 Prospect St., Ware. Total estimated cost, $200,000.

Conn., Bridgeport—The Peoples Ice & Cold Storage Co., 1335 Seaview Ave., has awarded the contract for excavating and laying foundations for a 7 story 100 x 150 ft. cold storage plant and 1 story, 65 x 100 ft. and 60 x 65 ft. warehouse, on Seaview Ave., to T. J. Pardy Construction Co., 1487 Seaview Ave. Cost, $25,000. Total estimated cost, $350,000.

Conn., West Hartford—Sleeper & Parisi, 26 State St., Hartford, will hold two 6 story, 70 x 180 ft. apartment hotels, on Whitney Lane and Arnoldale Rd. A vapor heating system will be installed in same. Total estimated cost, $325,000. Work will be done by day labor.

N. Y., New York—J. P. Stanley, 30th St. and North River, has awarded the contract for altering and building a 3 story, 100 x 175 ft. addition to warehouse, to Fanning & Quinn, 105 West 40th St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Md., Baltimore—The General Coffee & Tea Co., Light and Lee St., has awarded the contract for the construction of a 5 story, 83 x 197 ft. warehouse, to the West Construction Co., 907 American Bldg. Sub-bids will be received on steam heating, electric lighting and 2 electric elevators. Total estimated cost, $140,000.

Mich., Ecorse—The city has awarded the contract for furnishing and installing about 8000 ft. of water mains with hydrants, valves, etc., also 2 motor driven centrifugal pumps, 500 gallon per minute capacity, to T. C. Brooks & Son, West Grand Blvd., Detroit. Total estimated cost, $24,000.

Mich., Royal Oak—The Baker Land Co. has awarded the contract for the construction of a sewerage system, to include 2 motor driven centrifugal pumps, to Thorp & King, Royal Oak.

Mich., Ypsilanti—The Central Specialty Co., has awarded the contract for furnishing monorail equipment to the Sprague Electric Co., 40 Larned St., Detroit.

Ill., Chicago—The Quadrangle Club, Chicago University Campus, has awarded the contract for the construction of a 4 story, 60 x 140 ft. club house, to the C. Everett Clark Co., 69 West Washington St. A steam heating system will be installed in same. Total estimated cost, $225,000.

Ind., Fort Wayne—Thieme Brothers Co., Park Ave., has awarded the contract for the construction of a reinforced-concrete and steel factory on Runnion and Morrison Ave., to the Indiana Engineering & Construction Co., 528 Lincoln Life Bldg. A steam heating system will be installed in same. Total estimated cost, $185,000.

Ia., Des Moines—J. A. Wetmore, Supervising Architect, Treasury Department, Washington, D. C., has awarded the contract for repairing heating system in the old Post Office and Court House here, to the Bailey Plumbing Co., 404 West Grand Ave.

Kan., Manhattan—State Board of Administration, Topeka, has awarded the contract for heating system, to be installed in proposed 3 story, 50 x 112 ft., and 22 x 56 ft. engineering building here, to Miner D. Woodling, 512 Reliance Bldg., Kansas City, Mo. Estimated cost, $6152.

Mo., St. Louis—The St. Louis Independent Packing Co., 3815 Chouteau St., has awarded the contract for the construction of a 4 story 100 x 150 ft. by-product manufacturing plant on Vandeventer and Chouteau St., to A. H. Haeseler, Wainwright Bldg., St. Louis. Boilers, dryers and other equipment will be installed in same. Total estimated cost, $55,000.

Okla., Altus—The city has awarded the contract for improving of water works system, including installation of pumping machinery, to Maney Brothers, 304 Empire Bldg., Oklahoma. Total estimated cost, $62,500.

Okla., Oklahoma—The Mideke Supply Co., 200 West 1st St., has awarded the contract for the construction of a 3 story, 80 x 140 ft. main building and a 1 story, 75 x 140 ft. warehouse, to Reinhart & Donovan, Insurance Bldg. A steam heating system will be installed in same. Total estimated cost, $115,000.

Cal., Los Angeles—Paul Studios, Inc., Hollywood, has awarded the contract to Emil Fossler, 6434 Hollywood Blvd., for the construction of a motion picture studio on 20 acre site on Melrose and Crescent Ave., to consist of group of buildings to accommodate 30 producing companies, and central plant to serve all companies, including laboratories, one 100 x 480 ft. stage and three 100 x 350 ft. stages etc. Total estimated cost, including equipment, $1,500,000.

Cal., Willows—The city has awarded the contract for installing pump and motor, in Sewer District No. 2, to the California Hydraulic Engineering Co., 70 Fremont St., San Francisco, $914.

N. B., St. John—The city has awarded the contract for installing plumbing and heating systems, in connection with the proposed nurses home addition to the General Public Hospital, to R. E. Fitzgerald, St. Johns. Estimated cost, $15,780.

Ont., Port Arthur—The Canadian National Railways, Toronto, has awarded the contract for the construction of a 700,000 bu. grain elevator, to Barnett & McQueen, Port Arthur. Electric operated bucket conveyors will be installed in same. Total estimated cost, $600,000.

Ont., Walkerville—Essex Border Utilities Commission, Windsor, has awarded the contract for the construction of a sewage pumping staion here, to R. Westcott & Co., 39 Quellette Ave., Windsor. Estimated cost, $13,000.

A Personal Want—

can invariably be filled by a friend.

A Business Want—

must be satisfied by someone in your industry.

The Searchlight Section of this issue covers the current business wants of the machinery field

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